APPENDICITIS

H. A. ROYSTER

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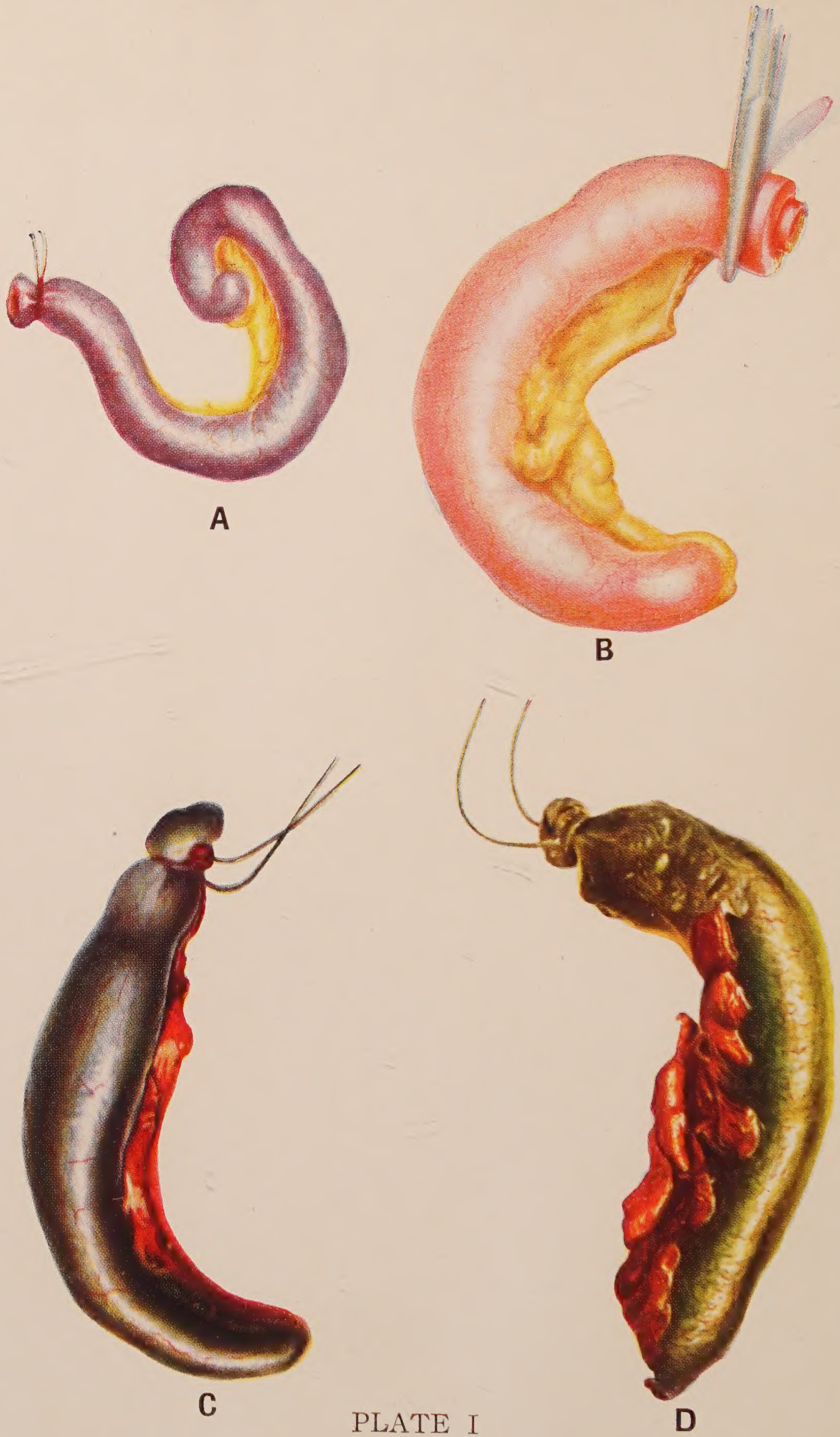

PLATE I

Descriptive Types of Appendical Pathology Representing Four Grades of Reaction
(Drawn from actual specimens)

A. "Angle Worm": subacute appendicitis.
B. "Shrimp": acute appendicitis, recurrent attacks.
C. "Snail": early gangrene of appendix.
D. "Green Worm": complete gangrene of appendix.

APPENDICITIS

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TO MY FATHER

W. I. ROYSTER, M.D.,

WHOSE MORAL STANDARDS, PROFESSIONAL ATTAINMENTS,
AND PROFOUND WISDOM HAVE BEEN AS A
"LAMP UNTO MY FEET AND A
LIGHT UNTO MY PATH"

PREFACE

A preface should, for the most part, be critical and explanative.—GERHARDI.

The purpose of this monograph is to present a study of inflammation of the vermiform appendix. The emphasis will fall upon the practical parts of the subject as concisely as a regard for clearness will permit, but nothing which will further its scientific understanding has been intentionally omitted.

An attempt has been made to review the important papers dealing with all aspects of appendicitis, chiefly those published during the past five years. The prominent books upon diseases of the appendix of whatever date have been freely consulted. To others is given full credit for their views. In many instances the author expresses his own opinions and suggests methods of procedure. These combined sources may well be taken to represent the current convictions concerning appendicitis.

No apology is needed for the publication of another book on appendicitis although many books have been written and much journal literature has appeared dealing with the subject.

Within the past few years no treatise on the appendix has appeared, while the numerous articles published in medical journals lack correlation and need integration in the light of more recently acquired knowledge and of enlarged experience.

Changes in our conception of the etiology of appendicitis have come about. New ideas in the field of diagnosis have sprung up. Advances in methods of treatment have been made both as to the disease per se and also the postoperative management. Some of these changes are for the better, others undoubtedly are not.

Indeed, very recently our mortality statistics have been challenged by those who are attempting to prove that the death-rate is not only not improving, but that it is actually increasing. Obviously such questions and challenges should be discussed both for the good of medicine and humanity so that we may apply ourselves more positively towards effecting better control of this still too prevalent disease.

This monograph is an effort based on the hope that it will clarify the questions which have been brought to the surface, by the shifting period which is now present, in our attitude towards appendicitis and that the writer's endeavor to stabilize contemporary opinions will be welcomed.

It is also the writer's fervent wish that this text will be of assistance to the general practitioner as well as to the surgeon.

HUBERT A. ROYSTER

Raleigh, North Carolina

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I. Descriptive type of appendical pathology representing four grades of reaction . . . . *Frontispiece*
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"LAST WORDS" ON APPENDICITIS

Is it time to stop talking about appendicitis? No! It is just the time to begin talking about appendicitis and talking most seriously and emphatically about it.

John B. Murphy (1915)

We have gotten into the way of looking at appendicitis as a minor operation. That is a great mistake. The appendix, when there is nothing wrong with it can be taken out by any one, but when there is something the matter . . ., it requires the very highest type of surgeon to take care of the case properly.

A. J. Ochsner (1925)

The exaltation of virulence in the closed cavity . . . sums up the entire history of appendicitis.

G. Dieulafoy (1911)

The last word on appendicitis continues to be the importance of early diagnosis with the prompt institution of surgical treatment; it is impossible that an operation be undertaken too early; it is a common observation that equivocation transplants such a procedure from the field of practical safety into the twilight zone of uncertainty.

Irvin Abell (Personal Communication)

I would lay much stress upon the seriousness of peritonitis more than the seriousness of appendicitis, unless it is neglected. Every case of appendicitis, other things being equal, should be operated on at the earliest possible moment, in the absence of forbidding peritonitis.

John B. Deaver (Personal Communication)

The most treacherous characteristic of appendicitis is shown in the astonishing rapidity with which it can develop alarming pathology and symptoms. . . . It sneaks upon its victim as does a venomous serpent, and common sense, after all our opportunities to observe, demands that, like the snake it should be scotched before it strikes.

J. Rilus Eastman (Personal Communication)

The proper management of acute appendicitis rests upon the correct estimation of the physiologic reaction to the pathologic attack in the *individual.*

Jabez N. Jackson (Personal Communication)

Operate early in cases of appendicitis; for the benefit of the adult patient as well as the reputation of the surgeon operate through a right rectus incision to permit investigation of possible complications, reserving the McBurney incision for children.

C. H. Mayo (Personal Communication)

APPENDICITIS

CHAPTER I

HISTORICAL SKETCH

Anatomically the vermiform appendix has been known since the sixteenth century; pathologically it was recognized in the eighteenth century; clinically it is the product of the nineteenth century.

It was first distinguished by Berengarius of Carpi in 1524, described by Vesalius in 1543 and further portrayed by Fallopius in 1560. In 1561 Vidus Vidius gave it the name of appendix vermiformis (Watson).

Appendicitis as a distinct disease is essentially modern. Collections of pus in the right iliac region were encountered as far back as the year 50 B.C. Wilhemi wrote a dissertation, *De perityphlide,* in 1837 (Heidelberg). In the preface the author quotes from Areteus (Cappadocia, circa A.D. 30–39), who seems to have been the first to describe this condition. Areteus reported a case in which he opened an abscess in the right side in the region of the colon. Much pus flowed from the opening, and for several days profuse discharge of pus came from the urinary passages. The patient recovered; a perityphlitic abscess most probably from appendicitis which had burrowed to the surface in the right abdominal region, at the same time perforating into the bladder. From the literature given by Wilhemi it will be seen that the condition was recognized and treated by a large number of observers before his time (Doll).

It is believed that a case of ileus reported by Farnelius in 1567 was probably due to a perforation of the appendix. More likely Hesiter's autopsy in 1753 was the first instance known in which the lesions are positively stated to be in the appendix (Deaver).

Credit for the first recorded case is generally given to Mestivier, a French physician, who in 1759 opened an abscess in the right abdomen of a 45-year-old man, and evacuated a pint of pus. At the autopsy he found a cecum "covered with gangrenous patches" and a large rusted pin in the vermiform appendix.

It is interesting to note that the very first instance of a diseased appendix should have disclosed a foreign body for its probable cause, as bearing upon the popular notion developing in our time that all cases were due to the ingestion of fruit seed and like material, which were supposed to be found in the appendix.

LaMotte in 1766 and Jadelot in 1808 published cases in which foreign bodies were noted in the vermiform appendix: the former, two instances, one of "whole cherries" in the cecum and in the appendix "a foreign body, as hard as if it were petrified," and in the other a "brittle stone" with a hair in its center; the latter, one case in which were seen four lumbricoid worms in the vermiform appendix. Over this period of fifty years only these four cases have come down in medical literature; they were all seen on the necropsy table and were reported by French physicians.

The earliest contribution on the subject outside of France came in 1812 from an Englishman, Parkinson, who was the first to call attention to perforation of the vermiform appendix as the cause of death. One year later a German, Wegeler, published in France a paper in which he describes and analyzes stones in the appendix, but regarded them as biliary calculi.

In 1824, after twenty years of silence, France returns to the scene and again holds the stage for some years to come. Louyer-Villermay at this time presented two cases with definite clinical histories, followed by autopsy findings, and recognized inflammation of the appendix as an individual disease. Three years later appeared the classical paper of Melier, the farthest advance yet made in singling out the appendix as the "original source of evil." After noting the cases of Villermay he reports one of his own, also seen at autopsy. The patient who seemed to be recovering gave himself an enema, and at once was seized by a sudden pain in the lower abdomen; peritonitis followed and death ensued after eighteen hours. The appendix was gangrenous, with multiple perforations. His description of the pathology and etiology is not far from what we know to-day. "In my opinion," he writes, "the fecal matter accumulated in the appendix, which then dilated little by little, becoming first inflamed, then gangrenous and finally perforated. The earliest symptoms, appearing in the form of colic, are probably accounted for by the inflammation and distention of the appendix; its rupture occasioned the effusion, which was responsible, in turn, for the peritonitis. The perforation was determined, or at any rate hastened, by the patient's exertion in taking an enema, since it was at this moment that the intense pain began, and immediately afterwards that peritonitis set in."

Howard A. Kelly gives Melier credit for drawing correct conclusions in regard to chronic inflammation of the vermiform appendix, and of its association with pus formation in the right iliac region; also, for priority in suggesting relief by operation. Kelly believes, however, that Melier's lack of moral courage and his failure to fight against the influence of Dupuytren, the great surgeon of his day, cost him his historical leadership in the cause which he so intelligently espoused.

Dupuytren never came to admit the causal rôle played by the appendix in suppurative swellings of the right abdomen, but to the end held on to the cecal origin of these masses while his pupils, Husson and Dance (1827) and Ménière (1828) published articles upholding his views. Thus a surgeon appeared to block the progress of determining the source of a disease which to-day is regarded entirely as a surgical malady.

But from this time on, pathological investigations of the ileocecal region continued to flourish. Germany furnished her quota of students in the persons of Merling (1827), Goldbeck (1830), aided by his chief Puchelt, Albers (1838), Genzmer (1824), Volz (1846), Schmidt (1847) and many others. All of these with the notable exception of Volz, continued to insist upon the cecal origin of the disease, suggesting the terms "perityphlitis" and "typhlitis" as expressing the primary pathology in affections of this region. Volz undoubtedly saw the light; for, in a list of forty cases studied at necropsy, he showed "that the condition known as 'perityphlitis' is not primary, but consecutive to inflammation of the vermiform appendix" (Kelly). He carefully analyzed and described fecal concretions and recognized their true composition.

English physicians once more enter the field and from 1832 to 1839, Copland, Hodgkin, and Bright and Addison contributed to our knowledge of diseases of the cecum and appendix. It was difficult for them also to get away from "typhlitis," and even now, if primary cecal pathology in its relation to appendicitis anywhere holds sway, it is in the British Isles. To Copland has been given priority for calling attention to trauma as an exciting cause of disease in the vermiform appendix, and also as being the first to discriminate between inflammations of the cecum, the vermiform appendix and the pericecal tissues (Fitz).

Bright and Addison presented a clear picture of the clinical signs of a diseased appendix and most careful guides to the management of the disease. Their description of the affection is a revelation: "That portion of the intestine which is lodged in the right iliac region is frequently the seat of inflammation, and affords peculiar symptoms, with which it is right that the student should be well acquainted. The history of this affection is often as follows: The patient has complained, more or less, for some time past, of pain and uneasiness in this part increased on exertion, or after neglect of the bowels, or excess in eating and drinking; he has, however, retained such share of health, that he has not been interrupted in his daily avocations, till after some unusual exposure to cold, or some long walk, or other over-exertion, he has been suddenly seized with more severe pain, attended with rigors, chills, and sometimes with sickness and violent vomiting. The pain and tenderness become excessive, and extend to the neighboring parts of the abdomen. A hardness and tumefaction are soon very evident to the hand in the part first affected; this continuing, general symptoms of peritonitis often take place, and terminate fatally; but under careful treatment, the inflammation remains circumscribed, and becomes even less extensive, assuming the form of a local, deep seated abscess. The threatening symptoms of peritonitis subside; the tumefaction just above the crest of the ilium on the right side is more and more obvious to the touch, and gradually shows a tendency to point; the constitution still suffering severely. In process of time it either opens of its own accord, or is assisted by the lancet, and a discharge of ill-conditioned pus follows, which, from its peculiar fetid smell, and from its appearance, is soon discovered to be mingled with feculent matter. The discharge continues for many weeks, and the patient often sinks at length from exhaustion. In other cases, when the powers of the system are previously unbroken, the abscess closes, and permanent recovery is obtained.

"*Morbid Appearances.*—From numerous dissections it is proved that the fecal abscess thus formed in the right iliac region arises in a large majority of cases, from disease set up in the appendix ceci. It is found that this organ is very subject to inflammation, to ulceration, and even to gangrene; and moreover, that it is occasionally thickened and ulcerated from tubercular deposits, if the peculiar diathesis favors that change; so that this little worm-like body is often detected in the midst of the abscess, with a perforation at its extremity; or by ulceration higher up in its parietes, a considerable portion of it, nearly or entirely separated, is found in a disorganized condition amongst the pus and feces which fill the abscess.

"*Exciting Causes.*—It is possible that the secretions of the appendix itself may sometimes become diseased, and give rise to inflammatory action in the part; sometimes we can plainly discover that stricture, amounting even to occlusion of the cavity, has taken place, so that the extremity has been distended with its own secretions; and this may probably give rise occasionally to inflammation; at other times we find little oval masses of feces impacted in the canal, which have pretty obviously produced the irritation; sometimes a foreign substance, as a cherry stone, or other seed, has been detected in the appendix; but one of the most common causes is undoubtedly the formation of a peculiar concretion which is moulded to the extreme cavity of the canal, and which is composed of coats or layers of the earthy phosphates, with occasional alternate layers, probably, of animal secretion, or of feculent matter."

A pertinent comment upon this remarkable observation was made by Randolph, who expresses what we all feel. "These great clinicians," he says, "were physicians to Guy's Hospital, and lecturers on the practice of medicine. The book quoted from was written for their students. These students were of sufficient caliber to appreciate the importance of Bright's disease of the kidneys, of Addison's disease of the suprarenals, and of Addisonian anemia, but seem to have ignored what should have been epoch-making observations on appendicitis. I can attribute it only to a state of mind as prevalent to-day as it has been in the past, *viz.*, a lack of interest in the post-mortem examination."

The remarkable features of a paper by Hancock, of London, published in 1848 were his successful operation upon a diseased appendix before fluctuation occurred and his insistence that the fecal concretions found in the cavity proved that the abscess began in the appendix. In 1850 Gay reported a case upon which he had operated for intestinal obstruction, exposing an adherent appendix as the cause—the first time (according to Kelly) "the abdomen was opened and the diseased appendix exposed to view."

It remained for American medical men to take hold on the knowledge thus far acquired in the older countries and to breathe new life into it, developing the subject steadily to its present state. The first case published in the United States is accredited to Richards, of Cincinnati, who in 1837 treated a man for fifteen days without being able to make a diagnosis, and at the autopsy found fecal matter in the pelvis coming from a perforated appendix. Hallowell, of Philadelphia, reported in 1838 a case with similar pathological findings, but complicated with pulmonary tuberculosis. In 1856 Lewis, of New York, contributed a very comprehensive review of the statistics, so far developed, of abscess and disease consequent upon foreign bodies in the appendix, analyzing lucidly the cases in the literature and exhibiting a knowledge of the pathology, with the marked exceptions of failing to differentiate the lesions and omitting to center his thought upon the appendix vermiformis.

Lewis' paper appeared nearly twenty years after the reports of Richards and Hallowell and it was another decade before any advance was made. Our previous investigators had been practitioners of medicine who studied their cases at necropsy or through the literature. The next step was to be taken by a surgeon, Willard Parker, of New York, who in 1867 published a paper dealing with successful operations upon four patients with abscess in the right iliac region, cured by opening and draining away the pus. From this time the surgical treatment of diseases of the vermiform appendix became an established procedure, only to be broadened and clarified by further study and technical experience. An American, Bull (1873), a German, Matterstock (1880), and a Norwegian, With (1880), joined in the march toward the goal of understanding. But all these observers were still harping upon "perityphlitis," and, although the right iliac masses were recognized, were considered in connection with perforation of the appendix, and many of the patients were saved by incision and drainage, the appendix was not removed and its primary agency was not clearly seen. Hall, of New York, in May, 1886, performed the first operation on the appendix in the United States, removing the gangrenous tube in the course of an operation on a strangulated hernia.

It was the master mind of Reginald H. Fitz, of Boston, a clinician and teacher of internal medicine, which in 1886 penetrated the fog of hazy knowledge thus far accumulated and singled out the appendix as the original lesion in acute affections of the right iliac fossa. He coined and first used the term "appendicitis," which ever since has been applied to this universal disease. As a pathologist Fitz sought for the seat of the disease and found in his autopsies that in most fatal cases of so-called typhlitis the cecum was intact while the appendix was ulcerated and perforated. Further he called attention to differences in length, position and patency of the appendix as bearing upon clinical conditions and insisted upon early operative interference.

Thus, by the careful, intelligent study of an internist, lesions of the appendi were relegated for all time to the realm of surgery where they hav remained. Beyond the question of a doubt the contribution of Fitz di more than that of any other, and perhaps more than those of all other combined, to demonstrate the exact status of the diseased vermiform appendix. Appendicitis might truly have been called "Fitz' disease."

Once for all Fitz proved that inflammatory affections of the right ilia fossa arose primarily in the appendix, and that such terms as typhlitis perityphilitis and paratyphlitis should be thrown aside. Confusion gave wa to order. Although a few physicians failed for some years to accept thi teaching, the great majority realized its truth, and at once the treatment o appendicitis by operation became firmly established. Following Hancock' case in 1848 over one hundred patients had been operated upon for abscess Krönlein in 1884 removed the appendix for acute inflammation, unfortunatel losing his patient. It has been currently accepted that in this case Krönlei had made a definite diagnosis and mapped out his procedure before operation; but Murphy believes the facts do not bear this out, holding that Krönlei operated for "intestinal obstruction or peritonitis."

From 1886 (the Fitz year) onward, surgical operations became not onl more frequent, but were performed with distinct purpose and with som degree of confidence, particularly on account of the then recent introductio of antiseptic technic. Thomas G. Morton, of Philadelphia, has received th merit for the first successful removal of the appendix (1887) in a cas deliberately planned beforehand, while Sands (later in the same year) sutured a ruptured appendix in a case in which he made a diagnosis of "acut septic peritonitis caused by perforation of the vermiform appendix."

Discussion of priority among advocates of these three men was continue for a number of years. Surgical literature began to overflow with report of cases, pointing out means of diagnosis, methods of operating, causes o success and failure. Senn stressed the importance of careful technic; Murph pleaded for prompt interference in perityphlitis.

Further advances came with the work of Charles McBurney, who in 188 urged operation in the early stage, paid much attention to the pathology o appendicitis and described what has since become the famous "McBurne point," as follows: "I believe that in every case the seat of greatest pain determined by the pressure of one finger, has been very exactly between a inch and a half and two inches from the anterior spinous process of the iliu on a straight line drawn from that process to the umbilicus." This diagnosti sign has been of inestimable value in separating appendicitis from all othe acute abdominal affections. When properly elicited it fixes the point o maximum tenderness to pressure. Time and experience have not diminishe its importance, nor has any other sign supplanted it.

A very sensible stand was taken by Worcester, of Massachusetts, wh in 1892 formulated some practical rules of managing appendicitis, far i advance of his time.

One of the real pioneers of this period was George Ryerson Fowler, of Brooklyn. He published in 1894 a series of papers upon appendicitis, afterwards made into book form, the first to be put out in America. Fowler's efforts were directed to the "interest awakened in appendical lesions, constituting as they do the most important inflammatory conditions of the abdominal cavity in the male at least," and to the study of "the truths," which did away with "typhlitis" and "perityphlitis," even as were "relegated to the musty pathology of the past such indefinite terms as 'parametritis' and 'perimetritis.'" Fowler spoke at that time (June, 1894) from a "personal experience covering now nearly two hundred cases of the disease." In 1912 William J. Cruikshank reviews the early history of appendicitis in Brooklyn and refers to Fowler as one "without whose name the history of appendicitis could not be written." It is also recalled that a meeting on October 20, 1885, almost two years before the reports of Morton or Sands, Fowler, discussing exploratory operations, said: "In like manner (by exploratory incision) can be definitely diagnosed diseased conditions of the vermiform appendix, perforation, etc. In these cases in which the diagnosis is only tolerably certain, ligature or Lembert's suture above the seat of disease or perforation, and a removal of this apparently useless portion of the alimentary canal, would then be indicated."

Cruikshank further notes a case which he saw on June 16, 1887, diagnosed as appendicitis with probable perforation, and urged operation. On account of Fowler's absence from the city, an associate of Fowler's was called in consultation, but declined to operate. The patient died of peritonitis, and autopsy showed perforation of the appendix. Cruikshank states that if Fowler had been present, he "would have removed the vermiform appendix six months earlier than did Sands, and Brooklyn surgery would, in all reasonable certainty, have to-day to its credit the honor of the first successful appendectomy." Comment naturally would include the suggestion that either surgeons should refrain from summer vacations or procure only progressive assistants.

Fowler's further contribution in 1900 to the subject—the one that has given him widest fame—was the so-called "Fowler position"; elevation of the head of the patient's bed twelve or more inches, thus causing by gravity the localization of the infectious product in the pelvis, where it is absorbed less quickly and whence it may be drained more readily. Used routinely in the cases associated with diffuse peritonitis, this posture has become a fixed principle. What might be spoken of as the extreme Fowler position consisted in raising the patient to a sitting posture in addition to the inclination of the bed. By the sad exigence of fate it so happened that Fowler, in 1906, succumbed to acute appendicitis, the disease in which he made so many investigations. It may be said that Fowler was the link between the old and the new in the history of appendicitis.

Other surgeons whose names will be everlastingly linked with the modern history of appendicitis are John B. Murphy, A. J. Ochsner, Joseph Price, Robert T. Morris, Maurice H. Richardson and John B. Deaver. In the year 1904 both Murphy and Ochsner issued their most important papers on the subject, the one in August and the other in October. Murphy's studies dealt chiefly with the spreading peritonitis cases in which he advocated "getting in quick and getting out quicker," placing the patient in the Fowler position, and the use of a continuous saline solution by the rectum—the now well-known "Murphy drip." In a series of similar cases Ochsner proposed a method of tiding over, since called by his name, and sometimes referred to as the "starvation treatment"; consisting of withholding everything by mouth, washing out the stomach, using the Murphy proctoclysis and giving morphin, if needed. Price very early joined the band of bold operators; Morris, in season and out, preached the short incision, rapid work and avoidance of injury to the organs and tissues; Richardson was foremost in doing operations in interval cases and invented the phrase, applied with fine judgment to certain cases of appendicitis, that were "too late for the early operation and too early for the late operation." The work of Deaver, extending from the late eighties to the present, has shown at all times an urgent appeal for early operation, a fearless surgical conception of the disease and a sound study of its clinical aspects resulting in advanced methods of operating, a type of incision, the publication of a book on the subject (last edition 1913).

In the past decade no decided advances or especial discoveries have occurred. Yet there have been improvements in technic, a relative reduction of the mortality rate, and a better understanding of the pathology and the diagnosis. Those who are now most concerned with the management of appendicitis should not be unmindful of the ancient and modern story of its development. In the chapters which are to follow the newer conceptions will be noted in the consideration of the disease in its various aspects.

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CHAPTER II

ANATOMY

The relations of the vermiform appendix to the cecum are so intimate and so important that any consideration of the former must include some account of the latter, both from a theoretical and a practical point of view.

THE CECUM

The cecum represents the lower terminal portion of the ascending colon, extending downward from its junction with the ileum. It is a blind pouch about 2½ inches (6.5 cm.) long and about 3⅛ inches (8 cm.) broad. Its usual position is in the right iliac fossa, resting upon the psoas magnus muscle. The peritoneum covers its anterior and lateral surfaces and its posterior surface is in contact with the loose areolar tissue over the iliac fascia. As a rule it has no mesentery. At times a true mesocecum is found, permitting much freedom of movement. In some cases the cecum is very long, hanging down in the pelvis; it may be tucked up under the liver owing to its failure to descend; it has been found in the midabdominal region and, indeed, almost in any position within the abdomen.

Orifices.—Within the lumen of the cecum there are two openings, one the entrance of the ileum and the other the orifice of the vermiform appendix (Fig. 1). The ileal aperture is narrow and slitlike, guarded by two folds of mucous membrane, forming the ileocecal valve, sometimes called the valve of Bauhin. Undoubtedly in the living subject this valve is competent, though experiments upon the cadaver to prove its efficiency seem not to agree, owing chiefly to loss of tone and lack of proper pressure. Each valvular segment represents a continuation of the mucous membrane and of the circular muscular fibers of the intestinal wall; the upper fold is nearly horizontal while the lower is about vertical, both forming shelflike projections into the cecum and acting to close the valve by approximation of the lower fold to the under surface of the upper fold. The mechanics of the ileum and the cecum may be compared to that of a plumbing trap in a sink.

The opening of the appendix is lower down, near the end of the cecum. Its location is very variable. Generally it is rounded or oval in shape and averages about .5 centimeter in diameter. A distinct fold of mucous membrane which presents at the orifice, especially when the direction of entrance is oblique, has been called the valve of Gerlach, who described it in 1847.

Some doubt exists as to whether it acts as a real valve. Kelly has demonstrated clearly that its function depends upon the angle formed by the appendix and the wall of the cecum; the more acute the angle, the more definite the valve effect.

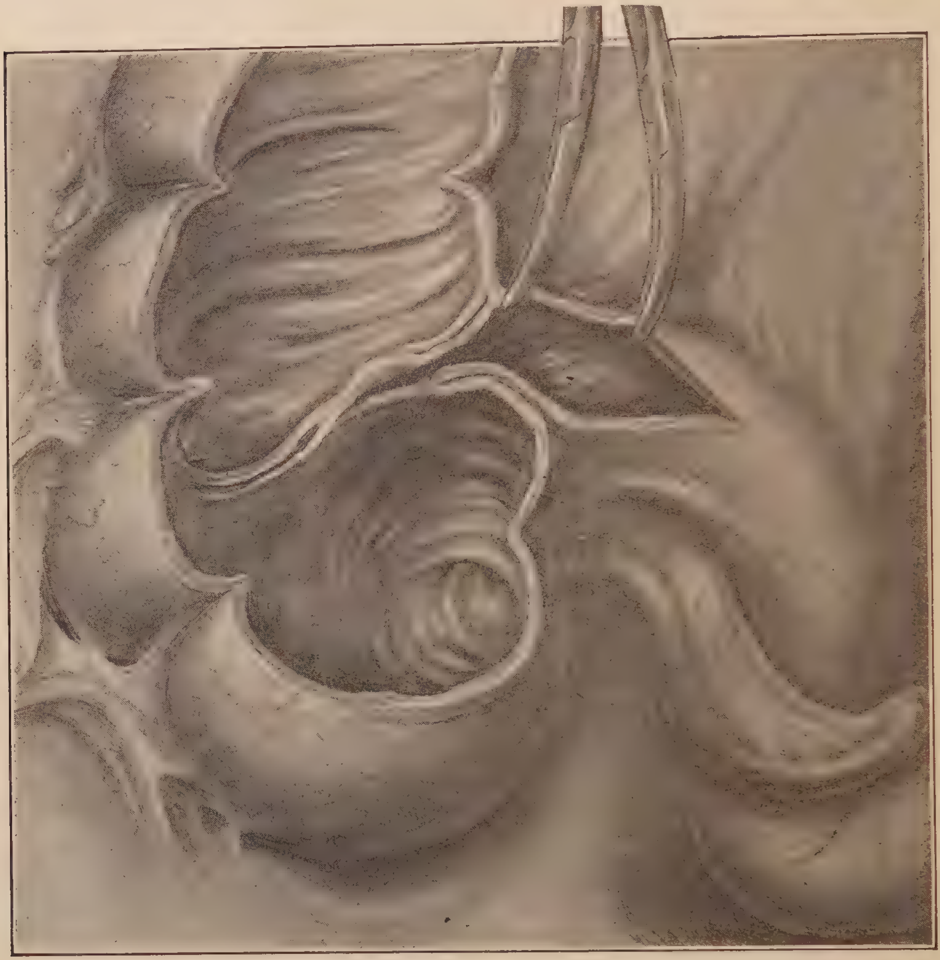

Fig. 1.—Anterior Wall of Cecum and Lower Ascending Colon Has Been Removed, Showing Entrance of Ileum Guarded by Ileocecal Valve (Bauhin) and Opening of Appendix with the Valve of Gerlach (Mucosal Fold).

Form and Structure.—In its form and structure the cecum is like the rest of the large bowel, having its longitudinal bands, its furrows and its corresponding coats; also, having no villi. Its pouches are marked, expanding between the bands, which end at the base of the appendix. Most anatomists describe only two main types of cecum: the fetal form, a tapering of the cecum to the left, the funnel-shaped end continuing as the appendix; and the much more common variety in which the pouch between the external and the anterior bands has outgrown the other portions, becoming the lowest and most prominent part, so that the appendix arises from the inner side posteriorly near the ileocecal junction.

Development.—Since the position of the appendix depends upon that of the cecum it may be well to review the development of these parts. Several of the ancient anatomists confused the cecum and the appendix, referring to the latter as the true blind-gut, while the head of the colon corresponded to what we know as the cecum. It is not clear just when the distinction was made, but certainly for over a hundred years the vermiform appendix had been considered as an undeveloped portion of the cecum.

In early fetal life the intestinal tract is a straight tube which after the first month forms itself into three main loops: from the forward loop is developed the jejunum and most of the ileum; from the middle, the terminal ileum, the ascending and transverse colon; from the lower, the descending colon, sigmoid and rectum. About the sixth week the cecum first appears, budding from the side of the middle loop and showing the line of demarcation between the small and large intestine. As the development proceeds the cecum for the first time begins to increase in length and from its blunt lower extremity there is formed a tapering point which becomes the vermiform appendix. By the more rapid growth of the small intestine a rotating movement is produced, so that the lower loop swings over to the left. At the end of the eighth week the ileocecal junction is in the lower left portion of the abdomen, but during the next two months it is gradually pushed upward and to the right by the small intestines and comes to lie under the liver. Later on the cecum with the appendix slowly drops downward, giving rise to the ascending colon, until at birth they reach their normal position in the right iliac region. The vermiform appendix process is distinct from the cecum at the end of the third month. Arrest of development at any state or failure to travel the usual route give rise to the abnormal positions seen in postnatal life.

Complete transposition of viscera, resulting in the location of the cecum on the left side of the abdomen, is of rare occurrence. A number of instances, however, have been recorded and the matter is of such practical importance as to demand further consideration. In Chapter VIII it is described in relation to disease of the vermiform appendix.

Embryological studies seem to indicate that the final location and shape of the adult cecum and appendix depend upon the period of their development at which they come into relation with the posterior wall of the abdomen.

When the contact is prevented by the interposition of intestinal coils no adhesions are formed, and the ileocecal mass is free and naturally placed; but when through displacement the contact occurs early, adhesions and fusions are produced high up, causing both the cecum and the appendix to rotate and shift their positions. They may be directed to the right or the left, drawn upward under the liver or pulled diagonally toward the midline. Such positions must be regarded for the most part as congenital. In 1,050 autopsies on infants the incidence of undescended cecum was found to be 6 per cent (MacLean).

Exaggerations and abnormalities, of course, are further favored by pathological changes. Elongation and preternatural mobility of the cecum result probably from fusion lower down near the ileocecal junction. Wilms, who described the condition known as cecum mobile, emphasized the great variability in the length of the cecum, and referred only to those cecums as abnormally long which could be easily drawn out of the incision and laid upon the abdominal wall.

Hertzler believes that "no one has ever seen a 'normal' cecum except the one depicted in the textbook of his student days," and denies that, except in rare instances, the cecum migrates toward the mid-belly region before attaining its position in the right iliac fossa.

During an operation Gardner encountered an ascending colon which was U-shaped with the base of the U in the normal position for the cecum. The colon was covered entirely with peritoneum. The cecum was under the liver, above and to the outer side of the hepatic flexure; the appendix to the inner side with its tip adherent to the neck of the gall-bladder. The cecum failed to descend, though the ascending colon was twice its normal length and had two loops, one being continuous at the hepatic flexure with the transverse colon and the other forming a blind pouch 4½ inches long ending at the cecum. This differs from the usual nondescent. The complete investment of the ascending colon, here noted, is also very rare.

In one thousand low cecums studied by Kantor with the aid of barium meals, they were on an average 2⅓ inches longer than the normally placed cecums which averaged 7 inches in length. The incidence of low cecum was 18.1 per cent. Seventy-nine per cent of these patients were women.

THE APPENDIX

The vermiform appendix (processus vermiformis) is a slender tubelike structure arising from the posterior-inner aspect of the cecum near its junction with the ileum. It varies in length from 1 to 11¾ inches—the latter the longest on record, reported in 1920; the average length is 3 inches. Its usual diameter is compared to that of a goose quill, but this also varies even in normal conditions. The diameter at the base is slightly more than at the apex. The cecal orifice of the appendix has already been described. The distal end, or tip, is blunt, and at times bulb-shaped.

Position.—The origin of the appendix is a more or less constant point, owing to the normally fixed relation of the cecum; but the terminal portion may point in any direction and its general position may be very changeable. Undoubtedly the most common position of the appendix is behind the cecum. Until the publication of recent studies two other positions were considered quite as frequent, *viz.*, mesial and subcecal. Very rarely the appendix has been found to be absent in man, though its complete agenesis is common in many vertebrate animals. Dorland notes that there have been recorded thirty-seven instances of this anomaly in the human, including one of his own.

Observations on the cadaver must necessarily be inaccurate since the position may be altered after death. Even in the living subject it is difficult through a small incision to get an absolutely correct view of the appendix without displacing the cecum—a fact which confirms the frequency of the posterior position.

Gladstone and Wakeley examined the vermiform appendix in three thousand persons at operation, on the autopsy table, and in the dissecting room. They have tabulated the results of their investigation as follows:

Position	*Number of Cases*	*Per Cent*
Postcecal and retrocolic	2076	69.2
"Pelvic," or psoas, near or hanging over brim of pelvis	825	27.5
Subcecal	56	1.8
Anterior or pre-ileal	27	0.9
"Splenic" or postileal	15	0.5
Ectopic	1	0.036

Leaving out the last notation, which represents an anomaly, there are five positions which the appendix may take and the great preponderance of the postcecal type is evident. This classification is much more simplified than others which have been proposed and corresponds more closely to the findings at operation. It is open to the same objection expressed above, in that no definite statement is made of the number of dead subjects as compared with the living. A consideration of these five positions is of importance to the surgeon in determining the location of abscesses.

There can be no question now but that the postcecal position of the vermiform appendix is the most common type (Fig. 2). Both anatomists and surgeons agree in these findings. But this view has not always obtained. Thus Ferguson in 123 cases described the appendix as being down in 11, mesial in 18, to the right of the cecum in 19 and behind it in 75, while a year later in Moscow, Turner studied 105 dead subjects and described 51 with the appendix in the pelvis (Fig. 3), 20 passing toward the sacral promontory, 6 lying on the psoas muscle, 22 behind the cecum in various relations. Bryant observed the appendix in 144 cadavers and reported the principal positions as 34 inward, 32 behind the cecum, 28 downward and inward, 21 in the pelvis, with others scattering. The summary of Monks and Blake on the position of the appendix from a record of 572 autopsies was as follows: Down and in, 179; behind the cecum, 104; down, 79 (Fig. 4); in, 62. These positions, it will be seen, represent about three-fourths of the total findings. Fowler adopted Bristow's classification and referred to 10 cases out of 40 which were found above a transverse line drawn from the anterior superior spine of the ileum to the midabdominal region (Fig. 5).

Deaver found in his operative experience that "the position of the appendix in the great majority of cases has been down and out, lying in the sulcus

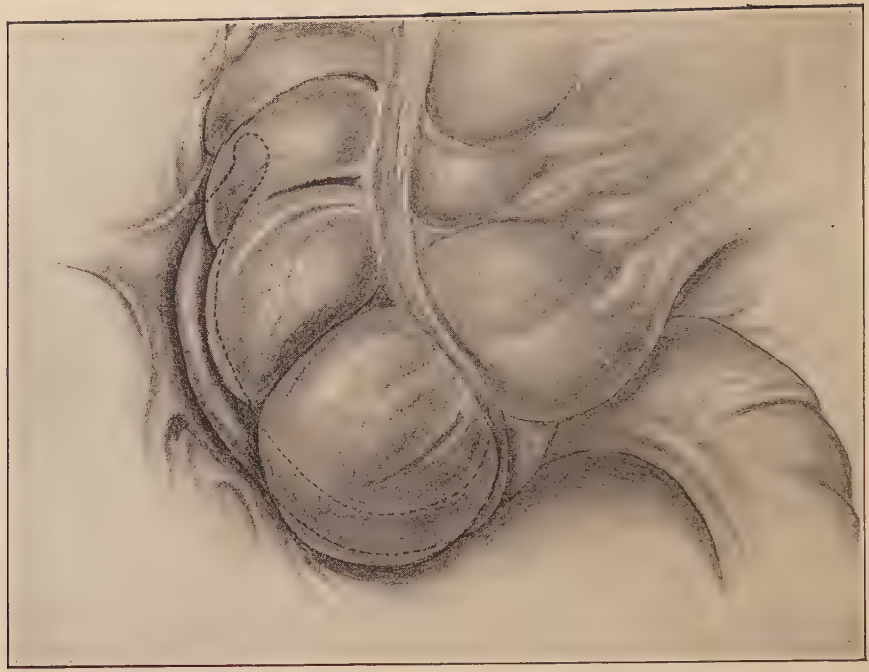

Fig. 2.—Retrocecal (or Retrocolic) Position of the Appendix.

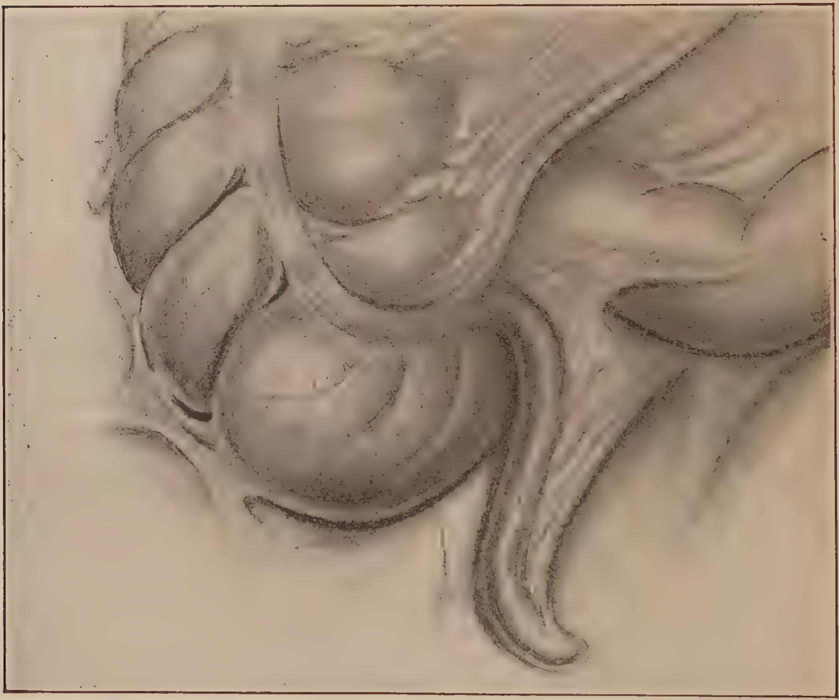

Fig. 3.—Descending, or Pelvic, Position of the Appendix.

in the outer side of the psoas muscle," but his dissecting room observations confirmed the statistics of Monks and Blake and others, namely, "that the positions of the appendix under the mesentery are most common" (Fig. 6). In another place Deaver refers to this position as "under the mesentery and directed upward and inward, inward, or downward and inward over the brim of the pelvis." It is likely that the reason for the discrepancy between these findings and those of later observers is that the former emphasized a wider classification and created more subdivisions of the posterior positions of the appendix, making multiple types which can be included under one general head (Fig. 7).

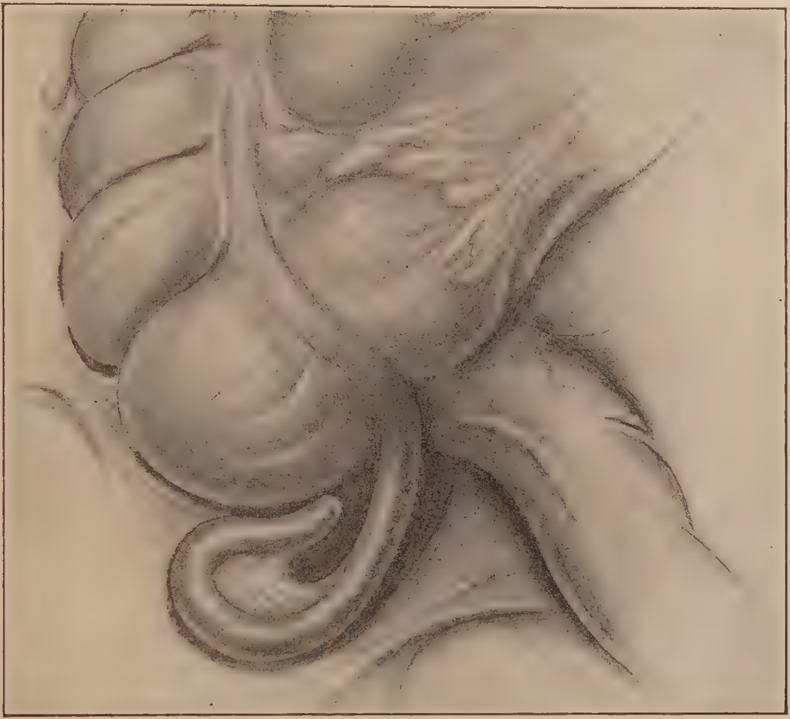

Fig. 4.—Subcecal Position of the Appendix.

More recently, growing out of the work of Gladstone and Wakeley, Crabb apparently agrees that in 70 per cent of cases the appendix is situated behind the cecum, and that this must be considered the normal position; but he thinks that possibly it is so considered because, on account of this position with kinking and impairment of its blood supply, the appendix is more liable to inflammation and therefore brought more frequently under observation. This might very well apply to living subjects, but would hardly bear out the postmortem statistics. Gardner also raises the same question, stating, that most of the appendices, which he removes and regards as pathological, are

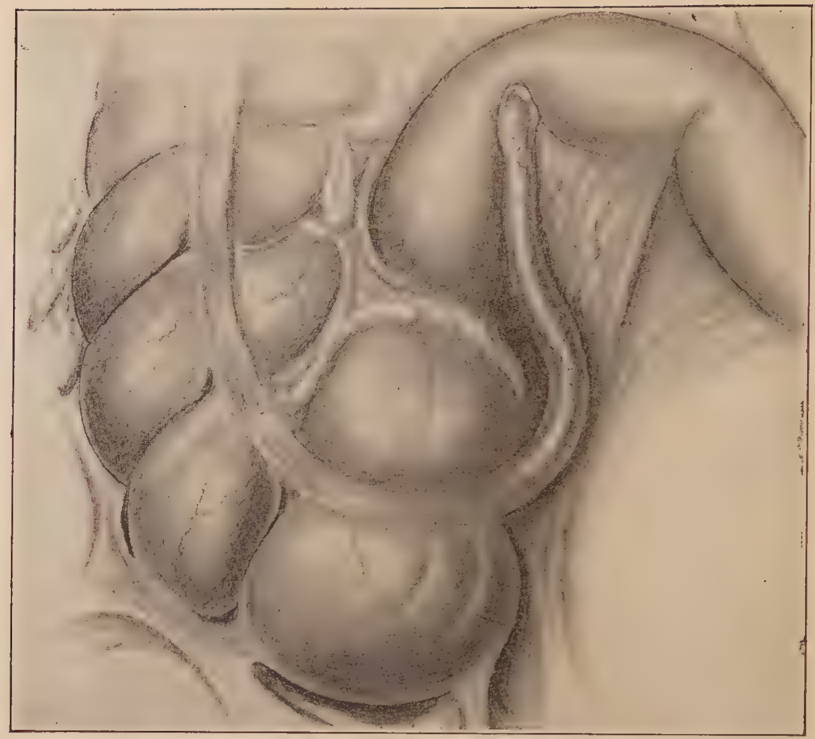

Fig. 5.—Anterior, or Pre-ileal, Position of the Appendix.

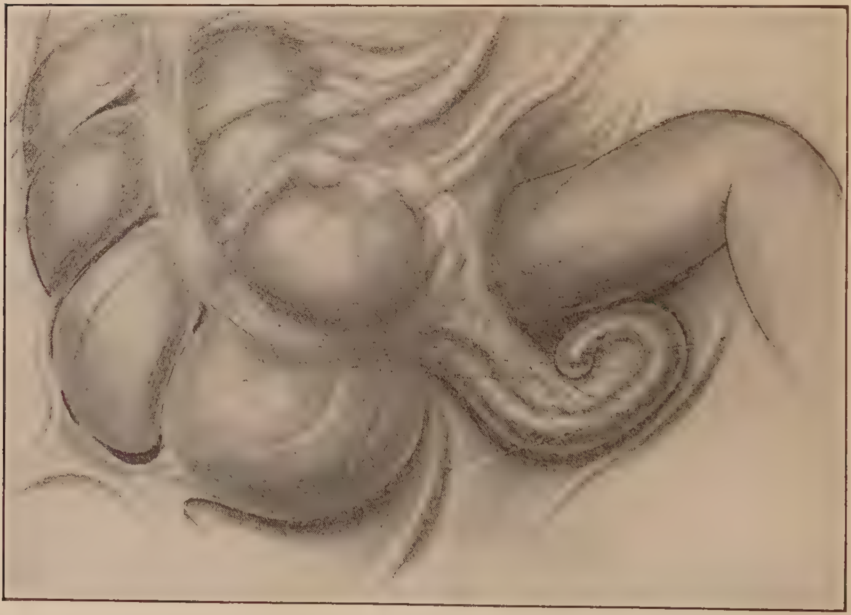

Fig. 6.—Postileal, or Splenic, Position of the Appendix.

postcecal in position and "that their blood supply and drainage is interfered with by some kink or bend of the organ or its mesentery." His records show observations which have not been made before—a differentiation of position in sex and race: White women, 59.4 per cent retrocecal; white men, 61 per cent; colored women, 78.4 per cent; colored men, 65 per cent. This presents an average of 60.3 per cent of retrocecal appendices for the white race and 71.7 for the colored race. From these statistics Gardner suggests the conclusion that the greater frequency of posterior positions in the Negro is due to his lower stage of development.

The practical evidence to be presented in support of the frequency of the posterior position of the appendix is the fact that in bringing the appendix to view at operation or autopsy it is necessary in the majority of cases to lift the cecum and turn it upward and backward. A rare anomaly of position of the appendix was observed by Köhler. He found it proceeding from the ileum 2 centimeters behind Bauhin's valve and suggests the following explanation: that, by a developmental disturbance, the pouch from which the cecum and appendix are formed became displaced from the anterior to the posterior limb of the embryonic midgut. Very few such cases have been reported, only three in fact.

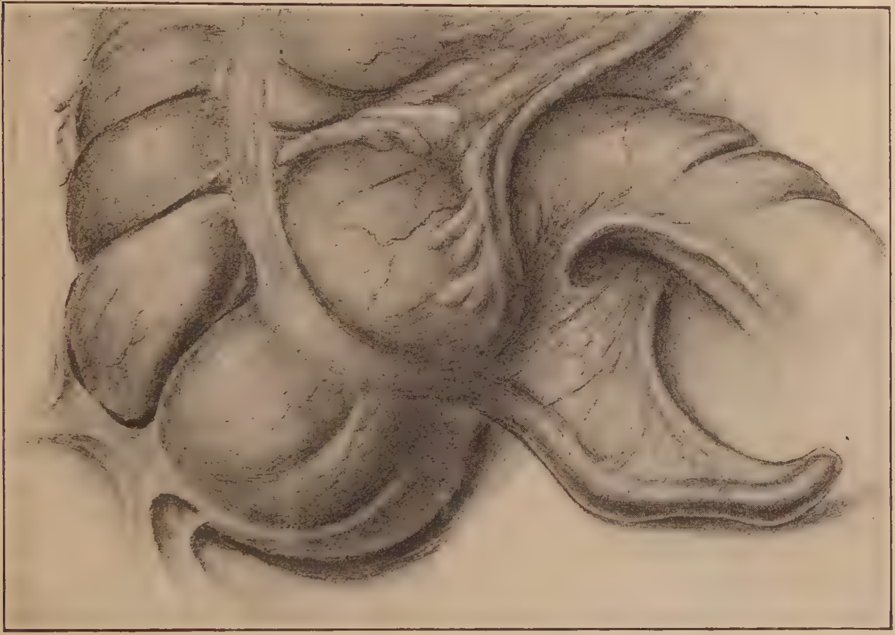

Fig. 7.—A "Neutral" Position of the Appendix.

The Meso-Appendix.—Since the cecum and the appendix are both completely covered by peritoneum, they cannot in the strictest sense have a true mesentery. But there is a double fold of peritoneum attached to the appendix running from its base along almost or quite its whole length. It is variously referred to as the meso-appendix, or the mesentery of the appendix, or the mesenteriolum. This structure contains, within its two leaves, blood-vessels, lymphatic channels and glands, nerves and fat (except in the infant). Its length, size and shape are variable. Usually it extends to the tip of the appendix or beyond; exceptionally it may stop halfway or less. Along its free border runs the appendical artery, which causes the fold to be formed and developed. The meso-appendix is always shorter than the appendix itself, throwing the organ into coils and twists and kinks, depending upon the extent and direction of its attachment.

Apparently triangular in outline, the mesentery of the appendix is found on careful investigation to be quadrilateral in shape. The four sides are represented by (*a*) the free border, (*b*) the attachment to the appendix, (*c*) the continuation of the left portion of the ileal mesentery and (*d*) the junction with the cecum. These last two are difficult to differentiate, but traction at the base will demonstrate their relations. This question furnished food for discussion over a period of years among anatomists, but now it seems settled as given. It is evident that the particular form of the meso-appendix in any given instance depends upon the point where the appendix arises from the cecum. If the appendix originates near the ileocecal junction, its mesentery is apt to be triangular; but when it comes off below, near the lower part of the cecum, its shape is quadrilateral. The latter is undoubtedly the prevailing form.

The anatomy of the meso-appendix presents questions of practical value. Its shape and size and length are seriously concerned in the operation of appendicectomy, especially in delivering the appendix, clamping and ligating its mesentery, and securing the blood-vessels. Careful scrutiny of the meso-appendix leads to definite localization of the appendix itself and intelligent handling of the parts at operation. Above all one should be prepared to meet all its phases and variations, and not regard any one type as being constant. Remembering that the artery of the appendix runs the whole length of the organ whether it be short or long, one must look for and clamp or tie this vessel and refrain from breaking it loose roughly by traction. One of the most difficult types to handle is the meso-appendix deeply enveloped in fat, the appendix lying almost buried in adipose tissue—a narrow cord atrophied and foreshortened (Fig. 8). When forceps or ligatures are applied, this fatty meso-appendix usually tears and crushes, giving rise to hemorrhage difficult to control or ripping up into the larger mesentery where greater damage may be done. Furthermore the meso-appendix is of great importance on account of the occurrence of embolism of its chief arterial trunk, which gives rise to a block in the meson and gangrene of the appendix. All sorts of anomalies of the meso-appendix occur: it may be rolled up, split and divided, fused with parietal peritoneum, extremely long, very scanty, or even entirely absent.

Lesser Folds.—In addition to the meso-appendix other folds of peritoneum exist in the region of the cecum and the appendix. Reference is made to those that are congenital in origin, related to natural anatomical development, and not to the frequent bands and adhesive structures resulting from chronic inflammation. Such pathological formations will be considered later.

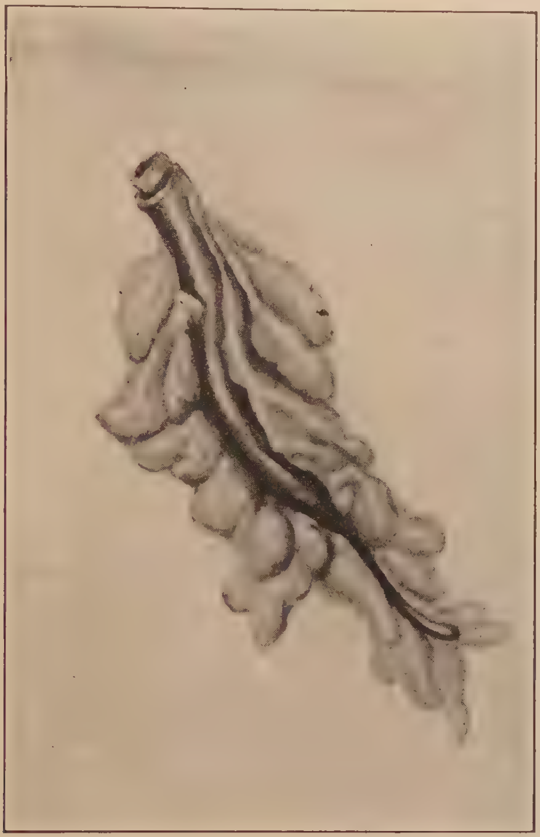

Fig. 8.—Appendix Enveloped in Fat.

Often it may be difficult to tell them apart. On this account knowledge of the normal folds is essential.

The *ileocolic fold,* as its name implies, passes from the ileum to the ascending colon at the upper angle of their junction. It arises in the mesentery of the ileum, crosses over in front of its terminal portion and fades gradually into the colon and cecum, at times reaching down to the base of the appendix. Along its free border runs the ileocolic artery and vein; between its layers are contained lymphatic vessels, and possibly glands and more or less fat. The fold is formed by the projection of the ileocolic artery, which may be so marked as to produce a real mesentery. The names of many anatomists and surgeons have been associated with this fold, notably among them being Waldeyer, Lockwood and Rolleston, Moynihan, Jonnesco, Tuffier. My experience confirms the observation of the last two authors as well as those of Treves and of Berry, who affirm that this plica is constantly found. Hertzler, however, does not concur in this finding, having observed the fold absent not infrequently. He attributes its existence to the relative size of the posterior division of the ileocolic artery, believing that if this vessel is large and well developed the fold is marked, while if the anterior division, which is the artery of the appendix, is large and the posterior relatively small, the fold is insignificant or absent. This explanation of its size is probably correct, but it would not necessarily cause the fold to be wanting, unless there were a more pronounced anomaly of the vessels or an entire absence of the posterior artery.

The *ileocecal fold,* though described by older anatomists, is now usually referred to as the "bloodless fold" of Treves. This author demonstrated certainly that, compared to the other folds in this region, it is relatively avascular. It is situated in the lower angle formed by the cecum and ileum; rather short but variable in length; generally triangular but sometimes quadrangular; occasionally so prominent that it overshadows the meso-appendix and demands attention before the appendix may be removed. That the fold is not entirely "bloodless" may be discovered when it is pierced by a needle, or torn in manipulation. Generally it is best to get under the fold if possible; but it may be cut between clamps and tied, if it interferes with the proper technic during operation. It has been mistaken for the meso-appendix. It may take on an oversupply of fat and in it some anatomists have discovered muscular fibers, but others have as positively failed to find them.

Further folds in this region are found behind and below the cecum and are therefore generally referred to as *retrocolic* or subcecal. They are not so well defined nor so constant as those already described, and in order to show them, the cecum must be lifted and turned outward or inward. Different observers have called them ligaments because of their probable action in supporting the cecum. The names of few investigators have persisted in connection with these folds, perhaps because of their number and their indefinite arrangement. Kelly thought that the subject could not be made any clearer by quoting the descriptions of various writers. His own studies led Hertzler to describe three folds which seem to be constant and important. The first is the *external parietocolic fold,* its outer half formed by the parietal peritoneum external to the colon and cecum and its inner portion continuous with the peritoneum along the posterior surface of the cecum. The second is the *internal parietocolic fold,* running along the inner border of the cecum and attached to the posterior parietal peritoneum, well-marked in children. The third is the *mesentericoparietal fold,* sometimes called the fold of Jonnesco, extending from the mesentery of the ileum to the posterior parietal peritoneum.

There are other lesser and more inconstant folds, chiefly along the outer border of the colon. These were formerly thought to be of pathological and clinical importance, but it is now believed that they are largely congenital and even if due to irritation or infection they are not directly concerned in the production of definite symptoms. Jackson's "veil" or "membrane" was the name given to the bands formed on the external portion of the ascending colon. Cignozzi is correct in classifying the true Jackson veil with the embryonic type of pericolic membrane. Other forms, inflammatory in origin and involving the appendix and cecum, are entirely different in character. The fold going downward from the ileal mesentery and made taut by pulling the ileum and cecum upward has been called the Lane "kink" after the surgeon who laid stress upon its presence as accounting for ileal stasis. While its significance has been exaggerated, the release of this band, so that the ileum may enter the cecum at a right angle, seems reasonable and appears to have given relief in some cases. The ligament of Clado, named for the investigator who first announced its presence (1892), is a fold of peritoneum extending from the right broad ligament to the appendix; or more specifically from the meso-appendix to the right ovary.

Fossæ.—The fossæ about the ileocecal region are merely recesses between the folds just described. They are indefinite and variable, but some of the more important ones may be noted. The *superior ileocecal fossa* is situated immediately underneath the ileocolic fold, which name is also applied by some to the fossa, opening to the left and extending to the terminal ileum below. It is often overlooked when it is shallow; distinct in infants, at times obliterated in adults. The *inferior ileocecal fossa,* sometimes called simply the ileocecal fossa, is shown plainly by drawing the ileum upward, the appendix downward and the cecum to the right. The area is bounded behind by the meso-appendix, in front by the ileocecal fold, on the left by the ileum and on the right by the appendix. The distal half of the appendix may occupy the whole space which varies from a shallow depression to a pocket nearly 2 inches in depth. The *retrocecal fossa,* at times quite deep, is formed by the cecum in front, the parietal peritoneum behind and the external and internal parietocolic folds on each side. It may be divided in the middle by another fold. The *subcecal fossa* is rarely seen, but it represents, according to some anatomists, a faulty development of the iliac fascia. Its boundaries are seen to be an unnamed fold in front, the parietal peritoneum behind and on the right, and the inner parietocolic fold to the left.

The most important and practical feature of these folds and fossæ is their inconstancy and variability within normal limits. These variations are noted even in the absence of disease or symptoms of any sort. For the most part they call for no interference and the advice of Hertzler is sound: "When the surgeon meets with a variation it should excite, first of all, his biological curiosity and not at all his surgical activity."

Blood Supply.—The appendix receives its blood supply from subdivisions of the superior mesenteric artery. This vessel gives off the ileocolic artery, which passes beneath the peritoneum downward toward the ileocecal junction, uniting by branches with the right colic, the terminal portion of the superior mesenteric and loops of its own to supply the cecum, the terminal ileum and the appendix. The artery of the vermiform appendix comes from its posterior division and courses along the meso-appendix to its tip, giving off branches as it goes. In rare instances these branches are not present. One or two small branches run separately to the base of the appendix from the cecal division of the ileocolic artery. The appendix, therefore, practically has a terminal circulation, with no direct collateral branches—a condition which accounts for the frequency of gangrene and perforation from plugging of its arterial supply. In the female an extra blood-vessel is derived through the appendiculo-ovarian fold.

The veins of the appendix begin in the tissues of its wall, run along with the arterial branches into the mesenteriolum, forming the vein of the appendix, which after collecting tributaries from the front and back of the cecum empties into the ileocolic vein and finally into the portal system. These venous radicles in the appendix itself have thin walls and large lumens. The practical observations concerning the arterial distribution in the appendix will apply to the venous arrangement.

Lymphatics.—The lymphatic vessels of the appendix originate in the mucous membrane and pass out through gaps in the muscular layer into the meso-appendix. Two sets of channels are described: the anterior run along the folds between the cecum and the colon and find their way to a chain of lymph glands on the inner aspect of the cecum; the posterior set empty into nodes behind the cecum, communicating with the glands of the mesentery, with those accompanying the external iliac blood-vessels, and in the female with the lymphatics of the pelvis through the appendiculo-ovarian plica. All of the lymph drainage of the appendix probably passes through the lymphatic ganglion, which rather constantly lies in the angle formed by the ileum and the cecum.

Consideration of this lymphatic distribution is important in its relation to infection of structures both near, and at a distance from, the appendix. The glands in the neighborhood are often found enlarged, especially in the subacute types of appendicitis. Recent studies by Braithwaite have directed attention to the flow of lymph from the ileocecal angle and its possible bearing on the production of duodenal and gastric ulcer. This author conducted a series of experiments upon both the dead and the living, animals and men, and apparently proved that normally the lymphatics of the appendix run for the most part to the gland group accompanying the ileocolic artery, going up to the chain lying around the superior mesenteric vessels, thence posteriorly to the lumbar glands; but that contrary to the usual belief there is communication between the ileocecal glands through lymph channels with nodes in the region of the right gastro-epiploic vessels, the pylorus, and even the common bile-duct. These chains in turn join round the trunk of the superior mesenteric artery where it passes through part of the duodenum. By the injection of dyes Braithwaite, moreover, was able to demonstrate that in diseased conditions there may be an aberrant and a retrograde flow of lymph from the glands in this region owing to obstruction of the normal canals by disease. From these observations, coupled with some clinical evidence, Braithwaite seems to conclude that appendicitis both acute and chronic may cause ulcer of the stomach and duodenum directly by the lymph channels, through which infective material flows, both forward and backward.

Berceanu, working under Gerota, made a study of the efferent lymphatics of the appendix in fifty-one newborn infants after the injection of dyes. His conclusions, important in relation to the lymphatic connections of the appendix and the duodenopancreatic region, were as follows: (1) The efferent appendical lymphatics follow the mesenteric vessels and empty behind the body of the pancreas into the lymphatic trunks of the right colon; (2) The first lymph glands which receive the efferent appendical trunks have a variable location in one of three groups, (*a*) a lower ileocecal group (thirty times in the fifty-one specimens), (*b*) a middle or mesenteric group (eighteen times), and (*c*) a superior or duodenopancreatic group (three times). In no instance did these lymphatic vessels drain into the region of the gall-bladder and according to Berceanu, this mechanism cannot explain the co-existence of appendicular and gall-bladder or bile-duct pathology (Fig. 9).

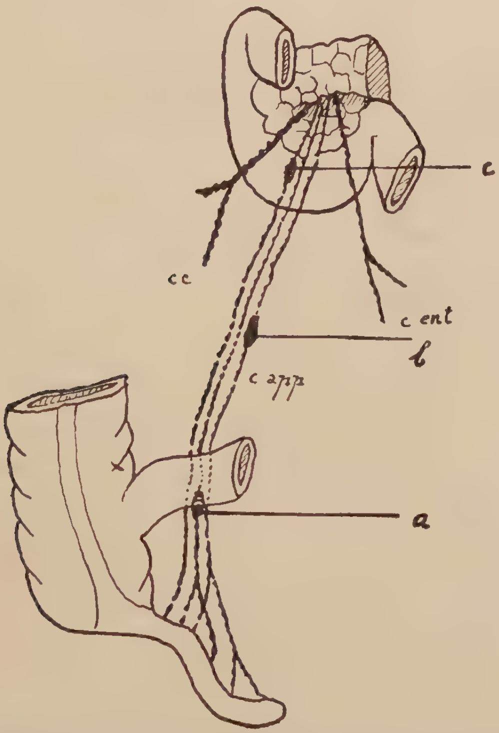

Fig. 9.—*cc*, Colic Collectors; *a*, Ileocecal Gland; *b*, Mesenteric Gland; *c*, Duodenopancreatic Gland. (After Berceanu, International Abstract of Surgery, *Surg., Gyn. & Obst.*, Feb., 1925, Int. Abstract, 123.)

Nerves.—The nerves supplying both the cecum and the appendix originate in the superior mesenteric plexus of the sympathetic system. From this same source converging in the solar plexus, the nervous distribution of a great part of the small intestine arises, explaining the widespread pain, commonly first felt at epigastrium or umbilicus, in inflammation of the appendix. The nerve branch which runs with the ileocolic artery sends filaments to the appendix, one group supplying the serous and muscular coats, the other going through the muscularis to the mucous membrane. This arrangement corresponds exactly with the distribution of nerves to any other part of the intestine.

Masson describes a periglandular plexus in the appendix. In certain cases of chronic appendicitis he found what he terms hypertrophied nerves and even neuromata. Their cells were not visible as ordinarily shown, but were seen when colored by an ammoniacal silver nitrate solution. These argentaffin cells, in Masson's belief, play a part in the protection and preservation of the nerves, being homologous with the Kultschitzky cells of the intestines and apparently belonging to an autochthonous system, possibly of the endocrine type.

Histology.—The microscopic structure of the appendix is similar to that of the cecum. Its coats are continuous with those of the large intestine and are four in number, designated from without inward as serous, muscular, submucous, and mucous (Fig. 10).

The *serous coat* is represented by the peritoneal covering common to all abdominal viscera and is composed of two layers, fibrous and endothelial. The fibrous layer is deeper, while the endothelial is on the outer surface.

The *muscular coat* also contains two layers—an outer longitudinal and an inner circular. The former is not so thick as the inner, wanting at certain areas, with flattened bands as in the cecum; the latter is quite thick, forming the greater part of the wall of the appendix and being twice the thickness of the longitudinal layer. It carries fewer vessels and less connective tissue. Numerous interruptions are seen in the muscular coat, giving points of contact between the peritoneum and the submucous layer and furnishing a way for the blood and lymph channels to reach the mesentery of the appendix.

The *submucous coat* is made up of areolar tissue of varying thickness, holding arteries, veins, some lymphatic vessels and follicles, and fat.

The *mucous coat* has a thin muscularis mucosæ of cylindrical epithelium projecting into the lumen of the appendix and backed up by the so-called tubular glands which may be branched at the ends. The lymph nodules are numerous and large; as many as two hundred in an average appendix, along with the glands, are fixed in loose connective tissue of the mucosa, extending almost to its free surface. A few follicles also penetrate to the submucosa. The appendix is abundantly supplied with lymphoid tissue and on this account it has been called "the abdominal tonsil." This analogy is most suggestive in children in whom the appendix is excessively rich in lymphoid masses.

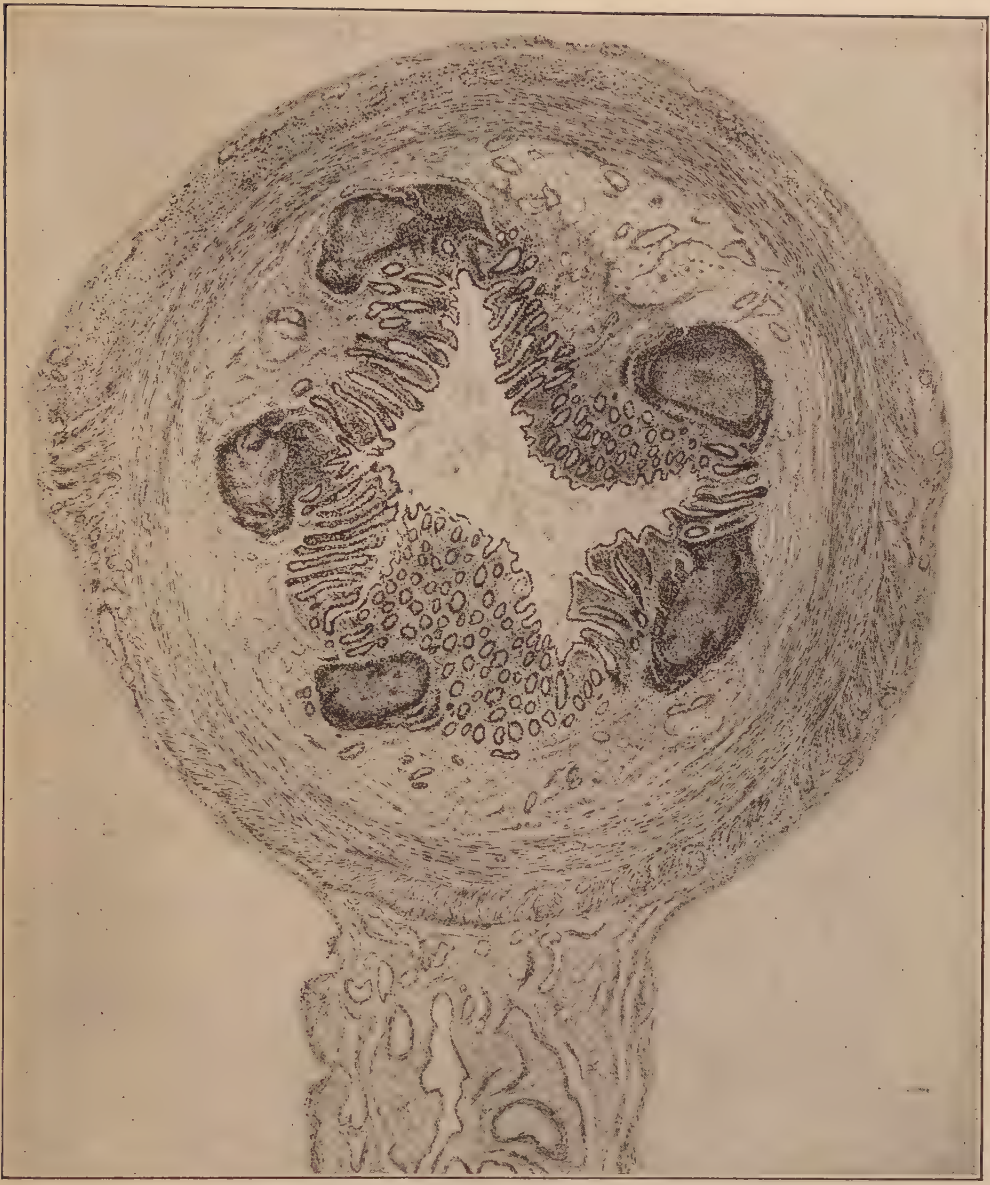

FIG. 10.—HISTOLOGY OF THE NORMAL APPENDIX. CROSS SECTION.

In the lumen are seen feces and mucus. The inner coat (mucosa) shows epithelium, glands of Lieberkühn and tunica propria; the submucosa consists of blood-vessels and fat; the circular muscular layer is next; then the longitudinal muscular coat, with bundles cut transversely; finally the serous coat, with superficial vessels. Below is the mesentery of the appendix containing vessels, connective tissue and fat. (After Kelly and Hurdon.)

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CHAPTER III

PHYSIOLOGY

Since the appendix generally is regarded as a rudimentary organ, it is looked upon as functionless. Whether it has now or ever had a function remains an open question. Its structure suggests a secreting apparatus and a defense mechanism. And one cannot but believe that in the lower animals before the different portions of the intestine became so highly specialized, the appendix may have played some part in the process of handling and digesting food.

Numerous observers have offered reasons for belief that the appendix yet performs some office in the human economy. Some assert that the appendix pours into the cecum from time to time a fluid substance which may prevent infection or lubricate the bowel; others believe that the appendix may extract from the cecum and take care of certain substances which are harmful. Keith went so far as to suggest that "all the food has to pass through the appendix for complete cecal digestion" a statement impossible of acceptance when we consider the present relative size of the cecum and the appendix.

Comparative anatomy would seem to prove that the appendix was relatively larger in the lower forms of life, more nearly the size of the cecum. As we ascend the scale, we find the appendix becoming smaller until in the more highly civilized man it is apparently decreasing in size. In the infant it is much larger proportionately than in the adult, and in certain races, like the Negro of lower unmixed blood, its size is markedly larger than in the white races. This involution strongly points to the existence of a function for the appendix at some earlier period in its development and bears out the impression that it is a vestigial structure undergoing atrophy from disuse. It must be admitted that proof of this is incomplete. It may be that after a relatively short biological period the appendix will disappear, be gradually wiped out. But during this process, as in every other instance of a retrogressive organ, the appendix continues as a menace and is subject to disease. It is this analogy of structure and function which gave the appendix the name of the "abdominal tonsil." On this basis it must be assumed that the appendix formerly had a function; that it is now of doubtful value to the body, rather dangerous than useful; and that finally it may be altogether obliterated.

There are those, on the contrary, who assert that the vermiform appendix is not a useless rudiment, but that it has a function to perform in the human body. The secretion of mucus from its glands has been considered to have a controlling influence on microörganisms within the bowel (Macewen), and also some action upon the fecal current through the ileocecal valve.

A unique and striking position is taken by Adami and McCrae. These authors could not agree that the appendix is a functionless organ, arguing that its complete absence is as rare as absence of the stomach, and that, while the stomach also varies markedly in size, no one regards it as a useless and disappearing organ. They are impressed with the mechanical relationships of the appendix and the large bowel in man as an erect animal. *"It is the appendix,"* they hold, *"that is the hydrostatic agent initialling peristalsis in the large gut."* These writers maintain that when the weight of the column of feces forming in the colon reaches a certain point its distending force acting upon the appendix walls below originates muscular contractions which spread directly into the cecum and so start the forward movements of their contents. Adami and McCrae further taught that "such a view explains constipation in the bed-ridden in whom this gravitational influence of the contents of the ascending colon can have little effect; it explains the normal tendency to empty the bowels, either shortly after rising and assuming the erect position or after the first meal when stimulating peristalsis of the small bowel has driven extra contents into the cecum and so increases the load; it explains the constipation that follows some interval removals of the appendix." "Appendical constipation" was a special point in their proof "through lack of initiation of colonic peristalsis, either from inflammation or other obliteration of the lumen of the appendix or operative removal of the same."

One sympathizes with their effort to prove the hydrostatic function of the appendix vermiformis and accepts the phenomena offered, but must feel some doubt concerning the sole agency of the appendix in producing the results.

Dufour elaborated a theory practically identical with the proceeding. He felt that the appendix plays a great part in provoking a desire for defecation independent of other reflexes concerned in the act. According to his view inflammation of the appendix disturbs its function by immobilizing the bowel instead of aiding its movements; while even without infection an appendix which is too movable excites the peritoneum and gives rise to hyperperistalsis with colicky pains. In the former condition constipation would be the rule and in the latter alternating diarrhea. Going Adami and McCrae one step better Dufour attempts to explain the mechanical rôle of the cecal appendage.

A still further elaboration of the function of the appendix is given by Gruner in what he calls "a study in histological pathology" of this structure. His article is illustrated by a diagram showing the essential components of the wall of the appendix and viewed as a living picture shows an active movement both in the tissue-elements and in the intestines. According to Gruner there are two streams constantly in progress. One of them passes inward from the lumen, reaches different levels and then passes out laterally. The other begins in the substance of the wall, also at different levels, and passes upward to the lumen and then to the right to enter the cecum. The integrity of the appendix depends on the continuance of these streams, and therefore on the patency of these outlets—one from the appendix into the cecum, one from the tissues into the channels which drain them.

The musculature ensures the patency of the lumen; the local circulation of blood and lymph maintains the patency of the tissue outlets; the free circulation in the lymph-spaces depends on the appropriate composition of the lymph.

The circulation of the fluid is thus described by Gruner: There are the two streams already mentioned—streams which at times amount to only an ebb and flow, at times give a definite flow in one direction, followed by another definite flow in the opposite direction. The outward flow is dual. There is the flow of material from the surface capillaries into the goblet-cells, and thence into the lumen; and there is the flow of material from the arterial capillaries in the submucosa into the perivascular connective tissue, taking the form of cells. First it appears as the lymphoblasts, then as mesolymphocytes and finally as lymphocytes. Just as the goblet-cells enlarge and pour out their contents, then slow up and again form new secretions, so the lymphoid follicles steadily enlarge as more and more cells are formed, until the whole mass has reached the surface, stretching out the epithelium enough to allow the lymphocytes to ooze through into that thin film of mucus which the goblet-cells are simultaneously discharging upon the free surface. Finally the follicles also shrink and fall back, and the displaced tissues return to their natural positions. This cycle of changes is part of the ordinary digestive cycle of the alimentary tract; the walls blush and grow pale—alternately great activity and "rest."

In the meantime the inward flow begins. The epithelial cells deliberately pick up solid material, as well as fluid and pass it into the tissue-spaces beneath them. Lymphocytes, now charged with food material, wander back between the epithelial cells. The phagocytes which have been derived from adjoining reticular tissue and from the endothelioid cells within the follicles, gather together under the epithelium, and ever hungry, are ready to convey these substances down into the deeper parts, and so ultimately into some vascular channel.

It has been established that the appendix has a motor function, since it is able to force foreign bodies which enter it back into the cecum. We look upon it, however, chiefly as a secretory structure. Binet and Dubois believe that it has a digestive secretion, a secretion to eliminate bacteria, and an internal secretion. Extracts derived from the appendix have been proved to be toxic in character. Investigations have shown that the appendix of the rabbit secretes abundantly a fluid, clear, viscous and alkaline, which is nonbactericidal; it will digest starch, but not fibrin or saccharose. Binet and Dubois conclude that the function of this fluid is to bathe the appendix canal. Other observers demonstrated that the secretions of the appendix possess some digestive action on the proteids, but almost none on carbohydrates.

Looking upon the vermiform appendix as a gland one realizes its capacity to produce lymphocytes and to resist infection. Beside the large amount of lymphoid tissue distributed throughout the appendix, there is also glandular tissue analogous to the blood-vessel glands. Masson has found in the walls of both the large and small intestines and in the appendix certain cells that stain gray or black with ammonia and these are described as forming "a diffuse endocrine gland which is the homologue of the islets of Langerhans in the pancreas." No one seems yet to have assigned a function to these glands.

But very recently Montier and Fouché have raised the question as to whether the appendix has an endocrine function. They observed marked obesity after early appendicectomy in at least five patients; in three instances there was disturbance of ovarian function, giving rise to dysmenorrhea or amenorrhea, persisting for one to three years, with hyperthyroidism; in two cases there resulted an apparent infantilism. These writers conclude that a certain endocrine function exists in the appendix and that its insufficiency may be gradually compensated in chronic cases.

Perhaps Boyd is wise when he says: "Many special functions have been ascribed to the appendix, but, until one of these can be definitely demonstrated by the experimental physiologist, it is useless to indulge in philosophical speculations."

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CHAPTER IV

ETIOLOGY

As in all other inflammatory affections, the occurrence of appendicitis is due to an invasion of bacteria and a lowered vital resistance. If it be admitted that the appendix is a retrograding structure, a point of lesser resistance is granted; the introduction of microörganisms from the intestinal tract is a constant affair. At any rate the anatomical position and the terminal circulation of the appendix render it susceptible to disease, while its blind lumen, opening into the septic cecum, invites infection. Whatever conditions enter into the production of such relations may be considered in the etiology. Many factors are concerned. In the last analysis it is difficult or impossible to say what actually precipitates an attack of appendicitis, or what brings about chronic inflammation of the appendix.

In general, those conditions which make the appendix liable to become the seat of inflammation may be put down as *predisposing* causes; those that directly produce the disease may be spoken of as *determining* causes.

PREDISPOSING CAUSES

The predisposing causes include age, sex, race, season and climate, geographical distribution, diet, anatomical position, family susceptibility.

Age.—Between ten and thirty years is by far the most common period for the occurrence of appendicitis. It is rare before five years, and after eighty years, although the disease has been seen in patients of ninety years and in infants a few days old.

It should be borne in mind that the age at which the attack was first noticed or the operation performed may not represent the age at which the disease began. Quite often many attacks, recognized or unrecognized, have occurred before the diagnosis is made or the operation proposed, so that the patient having appendicitis in the childhood period may not be brought to record until after the age of thirty. In my own experience a woman operated upon for a large appendical abscess at the age of seventy-eight years gave evidence of attacks of "colic" running as far back as her early twenties. Again, patients with initial attacks very early in life, promptly seen and operated on, will be put down correctly in the period to which they belong. Certainly over 50 per cent of appendicitis cases occur before the age of thirty years.

The overwhelming preponderance of the disease in the young and through early adult life is likely due to the abundance of lymphoid tissue and lymphatic vessels in the appendix at that period and the readiness of these structures to become infected, as well as the greater frequency of dietary indiscretions. The same observation holds good concerning the tonsils, mesenteric glands and lymph-nodes in other parts of the body during the same ages. Comparative immunity in later years, by the same token, may be explained by the atrophy of lymphoid tissue in the appendix and its surrounding areas. Obliteration of the lumen, beginning normally about the age of thirty and more or less complete in advanced life, also tends to prevent the access of organisms to the mucous membrane.

According to Seifert and Augustin who studied 1,383 cases in the Wurzburg Clinic, nearly one-half of the entire number were between the ages of eleven and twenty years. Their figures for the first decade of life showed 15.1 per cent and for the third 20.9 per cent; in the fourth, fifth and sixth decades the figure dropped rapidly to 7.9 per cent, 5.5 per cent and 2.9 per cent respectively. The eldest was seventy years of age. They found no cases occurring in the first five years of life and offer no explanation of the observation that at this early period the lymphatic tissue and mucous folds of the appendix are still relatively but little developed and that there is a freer communication between the cecum and the appendix, thus preventing a damming up of the feces and secretions. These authors quote Sonnenburg as emphasizing the fact that nurslings are wholly immune to appendicitis.

Schlossmann attributes the absolute immunity of the nursling to anatomic conditions. In the newborn all the layers of the appendix are relatively thin. Compared with the adult appendix there is only a slight development of the mucosa and submucosa, due to the weak structure of the lymphatic tissue. The number and size of the single lymph nodules are very small. The mucosa of the newborn consists of ordinary lymphocytes, myeloblasts, mast-cells and a few eosinophils; plasma-cells are absent. The latter distinguishes the appendix at this state from that of the nursling, the child and the adult. The superficial epithelium is composed almost exclusively of cup-cells, on account of meconium stasis, and undergoes changes soon after birth. The muscularis mucosæ is barely visible, while the other layers show nothing special.

At least three instances of a so-called *prenatal appendicitis* have been recorded. Jackson's case was that of a newborn infant who died of mercurial poisoning as the result of a bichlorid tablet accidently administered two days after birth. In his opinion the acutely inflamed appendix with definite adhesions found at autopsy made it certain that the disease existed prenatally. Reed observed a baby disemboweled at birth, the intestines breaking through along the umbilical cord. The appendix was found inflamed and adherent. It was removed, the intestines replaced and the child recovered.

Hill and Mason describe the case of a male infant, the first born of twins, weighing 5 pounds. The abdomen was distended at delivery. On the first day the baby took fluids, but began vomiting, which persisted; the temperature was normal and meconium passed. On the second day the distention was more marked, with evident obstruction and a temperature of 102° F. Death ensued on the third day. Necropsy showed a definite peritonitis: straw-colored fluid, plastic adhesions; terminal ileum, dark red; cecum, thick and edematous; appendix, 2 inches long, dark, swollen, boggy, filled with pus and débris, a perforation 1/16 inch in diameter 1/4 inch from junction of appendix and cecum on medial side; peritoneal fluid negative for bacteria; no sections of specimen made. The authors believe this case proves that peritoneal inflammation does exist in utero as evidenced by the fibrinous exudate and formed adhesions. No information was obtained in their case, they assert, to throw light on the etiology or time of onset.

Appendicitis in the opposite extreme of life has received special consideration in recent years. Case reports reveal a number of patients operated on in the *later years of life*. As was pointed out in a preceding paragraph, this does not mean always that the disease began at such an advanced age; often the lesion was carried over and culminated in the late acute attack. On this account perhaps a larger mortality is recorded in elderly people. Anderson records a case operated on in 1921. The patient was a stout woman of eighty-eight years, a sufferer from diabetes, who had an acutely inflamed appendix adherent to the bowel by masses of lymph. For a week her condition was critical and in the second week an area of 1½ inches of abdominal skin and fascia sloughed; but the patient recovered and lived three years longer. She had had a milder attack about a year before.

Maes, of New Orleans, takes the position that appendicitis in the aged constitutes a peculiar type. He agrees in the accepted view that the disease is relatively rare after fifty years, and believes that the very high death rate after this age is due to atrophy of the protective lymphoid tissue, causing frequent thrombophlebitis and massive gangrene, and also to the naturally lowered resistance of elderly patients, who are subject to organic affections of the heart and kidneys. According to Maes, "senile appendicitis," being vascular in origin and not merely a local infection of the mucous membrane, becomes a treacherous disease, getting under way before the objective signs are prominent.

Sex.—As a matter of practical interest the proportion of cases occurring in the two sexes is not of great importance. Except for the question of more difficult diagnosis in the female there is no clinical difference of moment. Most collections of statistics demonstrate a larger proportion of appendical disease in the male, some by a very large majority, others in lesser degree. Slight variations may be due to the type of hospital harboring the patients or to the character of work done by the particular surgeon.

In Fowler's hospital records up to 1900, out of 340 cases of appendicitis there were 244 in males and 96 in females, and he tabulated the studies of six previous observers, agreeing with them in their claim that 80 per cent occurred in males, to 20 per cent in females. Deaver's early experience indicated the same percentage, but afterwards he modified the figures, giving them as about 60 and 40 per cent respectively in males and in females, admitting finally (1913) that "appendicitis occurs nearly as often in females as in males." Sonnenburg gave his proportion of males as 67 per cent in a thousand cases; Roux 53 per cent in 673 cases; Barbier 76 per cent in 616 cases. More recently (1922) Seifert and Augustin, in the paper already cited, found the percentage of males 55 in round numbers, while they quoted Burger's figures of males as 50 per cent, Namowoa's 58 per cent, Ali Krogius' 59 per cent and Fromme's 60 per cent; but Gümbell over a three-year period found the number of males about double that of females.

Conversely a few observers have reported a larger percentage of appendicitis cases in women. Suermondt's thousand cases showed 487 males and 513 females; Hoffman recorded 1,448 males, 1,552 females; Löffler gave a ratio of 527 males to 627 females. The material of these authors undoubtedly would have contained a larger percentage of males, had their statistics included the morbidity prior to the World War, during which time the difference between the sexes was about equalized, due to the absence of so many men at the front. In 1910 McCosh felt that appendicitis was almost as frequent, if not more frequent, in the female than the male. In his three thousand cases there was a slight predominance of females.

Thus, while variations are seen, the general acceptance is that males are somewhat more liable to appendicitis than females. This has been my experience, particularly for the acute attacks in which the males have largely predominated; in the chronic type female patients have been about equal to the males—with the mental reservation that some of this larger percentage may have been due to extrinsic infection from pelvic disease.

Numbers of reasons have been advanced for the greater frequency of appendicitis in the male. These include: More strenuous activity and more vigorous occupation of the male; his more generous addiction to dietary errors, alcohol and tobacco; his greater liability to injury; the larger size of his psoas muscle. In addition the relatively less incidence of the disease in the female has been attributed to the fact that it has not always been recognized in the female; that she complains less than the male; that there is often much confusion in deciding between movable kidney, salpingitis, or ovarian disease and chronic inflammation of the appendix; that the more abundant blood supply of the appendix in the female through the appendiculo-ovarian fold (ligament of Clado) offers a certain protection against inflammation of the appendix—a matter which is offset, however, by the potential involvement of the appendix in disease of the female genitalia. The just conclusion is that sex as a predisposing cause of appendicitis must be considered in the light of the given patient, not forgetting the pelvic organs in the female as factors both primary and secondary.

Race.—Racial predilection to disease has been the subject of comment by medical authors from time immemorial. Usually founded upon illogical generalization from insufficient data the conclusions have been anything but scientific and informing. As suggested by Murphy in relation to the etiology of appendicitis, physicians often possess vivid imaginations. It seems well established, however, that the so-called enlightened races have been, and are now, more subject to infections of the vermiform appendix. The exact figures have not been worked out, but it is fair to say that the Caucasian peoples have so far exhibited the greatest numbers affected by appendicitis. As far as the question has been studied this excess is real, not merely an apparent one.

This does not imply that other races are immune. Erroneous and misleading statements, for example, have been made concerning the occurrence of appendicitis in the Negro. In Kelly's book the statement is made that "the Negro race, however, seems to be comparatively exempt from the affection," and this assertion is backed up by evidence to the same effect from four surgeons in different parts of the southern states. Later observations have served to modify these views. In 1906 I was able to bring out certain facts from a hospital service exclusively devoted to Negro patients and from personal communication with thirty-five surgeons, showing that appendicitis in the Negro was more frequent than generally supposed. It was further demonstrated that while appendicitis was not quite so common in the Negro as in the white its incidence in the Negro as in the white has been increasing, both relatively and absolutely; relatively because it is being recognized more clearly, objectively and subjectively, and absolutely because the Negro has been progressing, coming to live and subsist more like the white race. In Africa at this same period appendicitis was unknown in the black population; neither was it found in Alaska at the most northern habitation of man. It is a disease, then, of civilization with its complicated dietetics, and whatever produces a diseased appendix in the white will produce it in the Negro, who is more and more existing and eating as the people about him. All digestive disorders multiply as civilization goes forward, and the colored man with an inflamed appendix is no exception to the rule.

A similar study among Filipinos by Reyes in 1925 revealed a steady gain of appendicitis patients for the past few years. He reviewed 1,135 cases proving an apparent and an actual increase among the native population. The majority were of the student and clerical classes, who exhibited more modern, but not necessarily more beneficial, habits of living and diet, on account of their changed occupations.

Geographical and Seasonal Distribution.—The temperate zone appears to be the usual habitat of appendicitis. It may be that observations in other regions are inadequate and inaccurate or even so lacking altogether that no reliable opinion can be found; but all reports indicate that disease of the appendix occurs less frequently at the extremes of climatic conditions, just as it does at the extremes of life. The survey of Short showed that appendicitis is common in the more civilized European and American countries, rather uncommon in the more poverty-stricken places of southern Europe and very rare in Asiatics, Africans and Polynesians. He found, however, that when individuals from these races are taken into the service or society of Europeans and eat their food, these individuals acquire the Europeans' liability to the disease. Students from India who live in England, he says, are by no means immune. These observations correspond exactly with our study of appendicitis in the Negro of the southern states previously noted.

Appendicitis seems to be more frequent in the United States of America than in any other country on the globe. This may be accounted for directly by the supposedly more rapid methods of living, working and eating in America; or indirectly by the fact that the disease was first brought to attention clinically in this country and that we are more alert in looking for and operating upon appendicitis cases. It is held that our people are more guilty of dietary indiscretions; that is open to question. Certainly the reported cases in the United States far outnumber those from any other nation. As far as our knowledge goes no figures have been given out upon the incidence of appendicitis in the foreign-born population of our country living under the same conditions as ourselves, or according to their own habits before coming over.

Season and weather as affecting the occurrence of appendicitis naturally impress those who see a large number of cases over many years. Patients seem to come in at times by groups. We have noticed an accession of cases in the spring and in the early autumn, next in the summer, least in the winter. Deaver reported the largest number in the summer, with the spring next, attributing this to the increased frequency of intestinal disorders during those seasons. In a review of 1,150 cases treated in the Communal Hospital at Winterthur, Switzerland, from 1910 to 1919, Dubs discovered that the highest frequency was seen in March and April, and the lowest in February, May and September. It is likely that such findings are due to coincidence and that with the exception of less frequency in the winter months, there is little of striking moment in the matter.

Forster gives a series of tables, showing the prevalence of the disease during the various months of the year. He concludes that weather conditions, *i.e.*, variations of seasonal temperature, have no definite influence as to frequency, except, perhaps, in the summer, when stone-containing fruits are more eaten, and in individuals who have a predisposition to the disease.

Diet.—Food has been considered both as a predisposing and an immediate cause of appendicitis. Certainly in an intestinal disorder the diet must play an important part. Etiological questions already discussed in relation to geography, climate, race and season naturally are associated with diet, for the food is a vital factor in these conditions, different and characteristic in each situation. It has been shown that in the more civilized areas of the world appendicitis is more abundant, and the diet of these peoples is more complex and artificial than that of less populated and less enlightened countries. One of the former theories offered to explain the increasing frequency of appendicitis among the highly civilized nations is the prevalent use of roller-milled flour. The diet of the lower races contains a larger relative bulk of coarse vegetables and often a smaller amount of meat. Yet in some places like Abyssinia and Madagascar, where appendicitis is seldom seen, eating of meat is universal; and also among the Eskimos and Paraguayans, who live almost exclusively on meat, the disease is practically unknown. Referring to a statement of Perthes that the nature of the diet plays a large part in the causation of appendicitis Weischer reports that during his residence in China from 1915 to 1923 there were upwards to eighty thousand patients registered at the polyclinic. Most of them were of the poorest classes. Among them there were only two cases of chronic appendicitis, and one of these occurred in a Sister attached to a religious order which served European food only.

Corresponding to the influence of diet in the elevation of lower human races to the plane of advanced civilization, it is appropriate to record that apes in captivity apparently acquire susceptibility to appendicitis; the disease was found in ten out of sixty-one autopsies in chimpanzees (Short). We have, however, no report bearing upon the affection in apes still residing in the jungle. The relative difference has been attributed to the milk and bread diet given in the cage and the rough vegetables and roots in wild life. Experimentally Von Knierien founded in 1885 that rabbits fed on cellulose-free diet developed inflammation of the ileocecal region, while in carnivorous animals this did not occur. Since cellulose is not acted upon by the ordinary digestive ferments, it would seem that its effect is largely mechanical, for horn-shavings will act as a preventive. Ebner and Hoffmann (Seifert and Augustin) pointed out a certain relation between diet and the number of cases of appendicitis and thought that a meat and fatty diet predisposed to the disease. Thus, in Hamburg where the people subsist largely on meat, the figures are strikingly high, and in the same manner the figures were largely reduced during the World War when a more vegetarian diet was followed. Too great a weight, however, should not be given to curtailment of meat alone, for the number of cases was not materially changed during and since the War when there has been a lack of all kinds of food, both qualitative and quantitative.

Other observations in regard to diet are that institutions like schools and orphanages where the older and cheaper dietary prevails enjoy a relative immunity from appendicitis; that, whereas formerly this was a disease of the town, and country districts were more or less free from it, now there is little difference in its occurrence because home-grown produce in the country no longer holds its place and the diet of country and city is almost alike; that the modern rise of appendicitis in England since 1895 coincides with the time when that nation ceased to feed herself and depended on the other countries to furnish her food.

One is inclined to give ear to these statements by Short, from whom much of the foregoing has been abstracted. Moreover, as a philosophical summary of his discussion of the subject, the following may be quoted as his final observation: "When we come to piece together what we know about the distribution of the ailment, we shall readily conclude that it must be due to some food factor, but we shall need to tread warily in seeking to go further. So many baseless theories have been advanced that the late Dr.

Charles Mercier, with characteristic playful irony, maintained that the trouble is due to the abandonment of wig-wearing; there were no recorded cases from the days of Charles II, when wigs came in till the end of the eighteenth century, when they went out, except on the heads of judges, barristers, and Victorian bishops. He knew of no cases in legal luminaries—'and who ever heard of appendicitis in a wigged bishop?' "

Anatomical Position.—The anatomical relations of the appendix may have much to do with its becoming the seat of infection. Malplaced structures are more subject to disease than those normally situated. Variation of the appendix from what is regarded as its normal position would appear to act as a predisposing factor in producing inflammation. Kinks and twists, disturbed circulation, abnormal contact with other diseased structures may be brought about, so that infection is invited and received. These abnormalities may be congenital, or they may be acquired from improper habits of living and eating and as the result of certain occupations or some other intra-abdominal disease.

Jones-Evans stresses the mechanical factor in the causation of appendicitis and notes that one can find in textbooks of surgery no reference to any primary mechanical predisposing cause—a condition mechanically produced which in itself is the direct forerunner of the inflamed appendix. He believes that the great majority of the inflamed appendices are produced by rotation of the organ on its axis with its mesentery resulting in seclusion of the appendical artery and, the blood supply thus being shut off, in the supervention of infective processes. This condition is described as analogous to strangulated hernia, a twisted pedicle of an ovarian cyst, or torsion of the spermatic cord. In early cases the appendix was found partially twisted, giving rise to edema and congestion, according to the degree of torsion, which was usually from left to right; while in the later or severely acute stages, with complete strangulation, the distal end of the appendix becomes turgid and covered with flakes of lymph. The torsion may relieve itself and the acute symptoms subside, until a recurrence is produced by another twist. Rotation does not always occur; it is not likely to take place when the appendix is short or retrocecal in position, or when the abdominal wall is firm; visceroptosis predisposes to it.

Adams refers to the anatomical position of the appendix as having to do with inflammatory changes in it, and speaks of "any condition of stricture or tortuosity, which hampers the exit from the appendix" as favoring inflammation; "for distention will impair its blood supply and favor the activity of its contained organisms."

Nicastro observed a case of flexure of the appendix. It was 10 centimeters long and almost normally thick, and its distal portion (about one-third of the entire length) was bent kneelike against the remaining portion. The curved section was whitish and of fibrous consistency, while the remainder was of normal color and consistency. In investigations on dogs it was found that flexure of the appendix leads to chronic (never acute) inflammation of the curved portion only (hyperemia, edema of the mucous membrane, hypertrophy of all the tissues, etc.). There was no formation of new tissue, from which the author assumes that in cases in which this occurs it is due to an acute inflammation at some distance from the appendix or a long-persisting chronic inflammatory process at the site of the flexure.

The conclusions of Holder and Menninger are to the effect that adhesions about the appendix, cecum or colon are the most common mechanical abnormality; that appendical kinks occurred most frequently in the normal appendix and were commonly associated with the retrocecal position; that this position exercised a definite causal rôle in the production of symptoms, being found in 40 out of 208 cases.

The pressure exerted by other organs upon the appendix may furnish also the proper setting for disease in this structure. Adhesion to a pregnant uterus has made it necessary to remove the appendix; descent and contact of a movable right kidney will make the appendix more liable to disease; impingement can occur from a dropped cecum rolling over the appendix. Cignozzi considers marked splenomegaly as a contributing cause of appendicitis, and thinks the huge cecum found in these patients also should receive surgical treatment. According to McCosh the mechanical friction from a movable kidney is an etiological factor in chronic appendicitis.

Family Susceptibility.—That there is a tendency for appendicitis to attack members of the same family, often almost simultaneously, cannot be overlooked. Heredity will not justly explain the occurrence. It has been suggested that certain families may exhibit a peculiar conformation of the appendix or a personal diminished resistance against infection; but the real reason is doubtless to be found in the fact that the individuals are living under similar conditions and eating the same food. Every surgeon of large experience has operated upon two or more patients in the same family for appendicitis and had the familial type of the malady forcibly brought to his attention. It may be a matter of coincidence.

Tonio has boldly brought forward statistics to show a contagious character of the disease. This seems hardly tenable.

In a lengthy article Backman analyzes the material of his own cases obtained through the history and objective examination in order to gain a view of the hereditary relations of appendicitis to pulmonary tuberculosis, psychic and nervous diseases (hysteria, epilepsy, severe neurasthenia), diabetes, etc. He examined and operated upon 804 cases of appendicitis, of which 565 (70.3 per cent) were of the catarrhal and 239 (29.7 per cent) of the destructive form. His summary is as follows: Familial disposition was found in 21.6 per cent of the destructive and in 32.2 per cent of the catarrhal cases. In about 50 per cent there was a nervous (18 per cent) or a tuberculous (32.8 per cent) concomitant. Weakened bodily constitution showed 57.7 per cent and strong constitution only 8.4 per cent. The nervous system was involved in 76.8 per cent of the destructive cases (69.8 per cent males and 32.3 per cent females) and in 84.7 per cent of the catarrhal cases (72.5 per cent males and 88.7 per cent females). Gastroptosis in the destructive form was present in 34.7 per cent males and 79.7 per cent females; in the catarrhal form the figures were respectively 55.2 per cent and 77.7 per cent. These figures agree in general with those in persons having a weakened constitution. Complete defect of the cartilage of the tenth rib was seen in 3.4 per cent of the destructive form, and in 6 per cent of the catarrhal; slight defect was noted in 74.2 per cent and 73.2 per cent respectively. Dyspepsia was present in 51.6 per cent of the destructive and in 58.8 per cent of the catarrhal type. Anginal disposition was noted in about 15 per cent of the cases in both catarrhal and destructive forms and 20.5 per cent had hypertrophic tonsils.

In the substance of an expression attributed to Sir Berkeley Moynihan, "You can prove anything by statistics, even the truth."

As a summing up of current views upon the predisposing causes of appendicitis may be presented the results of investigations by Dieterich. His article deals with the material collected during the previous twenty-eight years (1894–1922) solely with the geographical distribution of twenty-five hundred surgical cases at the clinic in Marburg. The relative frequency of appendicitis to population does not point to a contagious nature of the disease. Questionnaires as to the frequency of appendicitis were sent to the various practitioners and city officials. In the 330 districts reported thirty were entirely free from the disease; in 110 only there was a slight morbidity rate and nine reported a specially high percentage. In fourteen districts appendicitis did not occur in several years, then suddenly there appeared a large number of cases epidemic in character.

Dieterich regards the matter questionable whether it is merely a coincidence that some place gives a high rate of morbidity whilst others remain free from the disease, or whether it is due to a deep-seated unknown cause. In addition to the pathogenic action of bacteria there are many local and general factors united to these, such as length and situation of the appendix, character of the colon, peculiarities of diet with tendency to frequent intestinal disturbances and finally racial peculiarities. The latter and climatic conditions had no bearing in his section. That geographical condition may really have some influence cannot be denied when we contrast other countries (China, Sumatra, etc.) where the disease does not occur, or very rarely so.

DETERMINING CAUSES

The determining causes may be put down in order of their importance as bacterial invasion, infectious diseases, fecal concretions, intestinal parasites, foreign bodies, trauma.

Bacterial Invasion.—Microbic infection is the essential cause of appendicitis. The appendix may be malplaced, kinked, injured, irritated and pressed upon, but unless bacteria infect its mucous membrane or its wall, no true inflammation occurs. Most frequent of all bacteria concerned in lesions of the appendix is the common bacillus of the colon. It is a normal inhabitant of the intestinal canal following birth and with the fecal contents passes in and out of the appendix lumen in the healthy subject. Obstruction of the circulation or undue pressure in the appendix from blocking of its exit will allow the invasion of its wall by infective microörganisms. Besides the colon bacillus the other most frequent organisms found in appendicitis are the streptococci of different types; the staphylococcus not so commonly; rarely specific organisms of tuberculosis, typhoid fever and actinomycosis.

While many cases exhibit a pure culture of the *Bacillus coli communis* and probably a few of the streptococcus, appendicitis is without question a mixed infection. Two or more organisms are associated, but the colon bacillus dominates the scene. The well-known disposition of this germ to remain of good behavior when given free rein and not molested, but to resent interference and to "hit back" when insulted, is exemplified characteristically in the causation of appendicitis. Given an unimpeded flow of feces through cecum and appendix and an uninjured intestinal lining, the colon bacillus is quite innocuous—indeed, somewhat beneficial in its attitude—but, when imprisoned or disturbed by any factor which impairs its natural surroundings, inflammation ensues. It has power to penetrate the intestinal wall and to invade other tissues and organs. If these causal factors are severe and sudden the acute fulminating type of appendicitis supervenes; if they act mildly, but continually or recurrently, the chronic form results. Between the two there is a medium degree represented by the subacute type, which may grade into the other two.

Studies by different observers confirm the evidence of mixed infection as the constant course. In 160 cases Bagger and Mikkelsen found streptococci alone in two and the pneumococcus in none. The colon bacillus appeared in all of the fourteen fatal cases and in all but four of the total number. The staphylococcus was associated in one fatal case. In four of those that died the *Enterococcus proteiformis* was noted, and in three it existed in pure culture. The last observation may not carry great significance, since the *Enterococcus proteiformis* is put down as only possibly pathogenic and exists in various forms. Warren presents sixty-six cases of acute appendicitis in which the *Bacillus coli communis* was most commonly encountered, alone in twenty-five cases and combined with other bacteria in twelve. The *Streptococcus hæmolyticus* occurred alone in six and combined in nine; the *Proteus vulgaris* and the *Bacillus pyocyaneus* each five times; others were scattering.

Anaërobic germs also appear to be concerned especially in the destructive forms. From examination of the exudate of a large number of appendicitis cases complicated by peritonitis, Brütt found a distinct regularity in the presence of anaërobic streptococci, along with the ever constant colon bacillus. He attributes to these anaërobes a definite relation to the gravity of the case, and, among the few authorities on this question, he quotes Heyde as having demonstrated in twenty-six cases of peritonitis with perityphlitic abscess the presence of anaërobic bacilli, in addition to the aërobic forms. In the series of 107 cases reviewed by Brütt there was not a single case of pure culture of anaërobic cocci and it seems, therefore, that the colon bacillus is an inseparable companion to the anaërobes in destructive appendicitis. Mono-infection with the colon bacillus, however, is relatively frequent, occurring in thirty-six out of the 107 cases; while only eight cases showed mixed infection of the colon bacillus with other aërobes.

We may conclude in the language of Warren that appendicitis is not "a specific disease due to one type of organism, a streptococcus, as is sometimes maintained. Like acute tonsillitis, acute endocarditis and similar infectious lesions, it may be caused by a variety of organisms."

Infectious Diseases.—The association of appendicitis with general and local infection elsewhere in the body has been considered for many years. The older writers noticed the relation between rheumatism and appendicitis and for years even previous to 1860 medical literature was full of comments upon the close connection between these two affections. Later on tonsillitis was seen to be a constant accompaniment of rheumatic attacks and appendicitis often followed or preceded both. Now that we know rheumatism as another name for infectious arthritis coming largely through toxic tonsils, and that toxins can be carried from one part of the body to the other through the blood stream or by way of the intestinal canal, it is easier to understand the rôle which systemic infections may play in the production of appendicitis.

Influenza.—One of the most important of the diseases apparently related to appendicitis is influenza. So impressive has been this association that even from the earliest appearance of "la grippe," observers have asserted that this prevalent malady was the real cause of infection of the appendix. It is quite consistent that the two diseases should stand in a causal relation, not only from the view of the metastasis of a general infection to a local area, but also because certain types of influenza attack directly the mucous membrane of the intestinal tract, of which the appendix is a vital and a vulnerable part. Numbers of authors have noted that during and following epidemics of influenza there is a great increase in the frequency of appendicitis. Sonnenburg, Adrian, Finney, Marvel and others pointed out the close relation of the diseases and the apparent increase of both in the past few years. But Rostowzen in Russia, after investigating over three thousand cases, said that influenza has little to do with the etiology of appendicitis. In the experience of Seifert and Augustin during the epidemic of influenza in 1918 statistics from all sources showed a decided increase of appendicitis cases and they believe in a causal connection between the two infections. According to Ruge influenza is undoubtedly a causative factor in appendicitis. He reports thirty-four cases, of which thirty were operated on. All were of the acute variety. At operation the appendix showed necrosis of the mucosa in four, hemorrhage in two, exudate into surrounding parts in two, adhesions in three, perforations in one, and nodular thickening with marked edema in eleven. The appendix contained feces in three, feces and pus in two, stercoliths in eleven, bloody mucus in three, pus in two and oxyuris in five. The close relation of grip to appendicitis is shown in Ruge's experience, by the fact that in the month of August there were admitted to his hospital thirteen cases of the former and seventeen cases of the latter.

One must be exceedingly careful not to draw too sweeping conclusions in the matter of a widespread disease like influenza. In pandemics of this affection whole communities are included, and especially those of the appendical age incidence; so that it might be difficult to find a young adult with appendicitis, who had not also been a victim of influenza. No doubt exists, however, in the minds of those who have had most experience, that influenza chiefly of all the infectious diseases is a determining agent in appendicitis.

Typhoid Fever.—Typhoid fever probably bears some relation to the occurrence of appendicitis—left-over organisms giving rise to local inflammation at a point of irritation. In former days when typhoid infection was so very common, it was usual to think of it as a causal factor of later diseases; and our experience led us to believe that its importance as a forerunner of appendicitis was only next to its agency in the production of gall-bladder infection. Not infrequently appendicitis comes on in the course of typhoid fever.

Diseases of Childhood.—Diseases of childhood such as measles, mumps, scarlet fever and chickenpox are often followed by appendical infection. Rarely the appendicitis may occur during the acute course of these diseases or a few hours or days following convalescence. The abundant lymphoid tissue of the appendix affords a favorable nidus for microörganisms through the general circulation and it has been proven experimentally that the bacteria will lodge there when injected at a distant point. Moreover in many cases of exanthematous infections there is also an acute enteritis, which would bring about the necessary lessened resistance. Measles seems particularly prone to be associated with appendicitis and the combination is a very serious one.

Fecal Concretions.—It is an undecided question whether or not under normal conditions feces are accustomed to pass in and out of the appendix. That this happens is apparently proved by the finding of fecal matter in the lumen of appendices removed during abdominal operations when no symptoms of appendicitis existed and no appendical lesion was present. In a personal communication to Holder and Menninger Kümmel is emphatic in saying that "no normal appendix contains feces. If such is found then an early nidus for pathological changes is present." If, however, the exit is blocked, masses collect in the appendix, become imprisoned and are referred to as fecal concretions, or fecaliths. They may range from soft molds, single or multiple at times, forming a complete cast of the appendix, to hard concretions of small or large size and of varying consistence and number. Formerly these masses were mistaken for grape seeds, cherry stones, etc., but upon careful examination they are seen to consist of inspissated feces arranged in concentric layers, packed down harder and harder to a central core, denser than the outer surface. The formation and structure of fecaliths will be considered in the chapter on Pathology.

Fecal concretions could be classified either as remote causes of appendicitis, or as immediate causes. As a matter of truth they may be treated under both headings; for by their presence they irritate the mucous lining of the appendix, favoring the germ entrance, and by pressure they cut off the circulation of the appendix, thus precipitating an acute attack. Furthermore concretions play the dual rôle of cause and effect. Their formation is proof of some disturbance already present (low-grade infection, kinking, incompetent valve) and in turn they accentuate the existing lesions and create further disorder. Thus, there is established a corrupt circle which seals the doom of the appendix. It is loaded and only the fall of the trigger is needed to shoot the gun.

Authors have commented from early times upon the presence of fecal concretions and their relation to disease of the appendix. For the most part these masses when found were looked upon as the sole provoking causes. The study by Wegeler in 1813 of concretions found at necropsy was the first serious effort to discover the part played by these bodies. He did not regard them as the actual etiological factors. In 1848, it may be recalled, Hancock suggested that the fecal concretions found in the wound furnished proof that the lesion had its origin in the appendix. The elder Gross in 1882, writing of "stercoraceous or perityphlitic abscess," believed that the most common cause was "the lodgment of some extraneous substance" as a "calculous concretion," "indurated feces," etc. Fowler felt that fecal matter of itself did not necessarily give rise to the disease, but that concretions by their presence in an already devitalized organ might produce ulceration and gangrene.

Dodds Parker, of Oxford, England, personally suggested to the writer in 1913 his belief that the fecalith was the actual agent in perforation of the appendix with or without gangrene, adding that a concretion is practically always found in the appendix at the perforated portion or outside near the opening. Our own experience would almost coincide with this—but not quite. The larger number of ruptured gangrenous appendices show one or more concretions which, as now considered, may be both cause and effect. But there are too many perforative cases without the presence of fecal stones to say that they are the only causal factors in perforation. Surely, however, they initiate the rupture in many instances. Packard encountered the largest appendix stone on record—measuring 4×2×1 centimeters—which protruded through a ragged hole in the appendix, evidently made by pressure necrosis, with no pus present. One may feel quite certain that an appendix containing concretions is already the seat of a pathological process and that their continued presence will lead to further disturbance.

Intestinal Parasites.—It is not uncommon to see animal parasites in the lumen of the appendix. From time immemorial they have been recorded. It is said that Fabry of Hilden (1560–1624) was the first to describe their presence in the appendix. In 1901 Metchnikoff distinguished a type of the disease which he called "verminous" appendicitis. This was not generally acceptable. Matsuoka referred to it as "pseudo-appendicitis zoöparasitica."

The causal relation of intestinal parasites and appendicitis is still unsettled. The worms seem to be found chiefly in the subacute and chronic forms of appendicitis, rarely in the acute cases. Sometimes they are seen in the perforated types and in many instances are known to have escaped into the peritoneal cavity. It cannot be questioned that they act as a direct factor in the production of inflammation of the appendix, similar to the part played by fecal concretions. Their entrance into and retention within the appendix lumen are due to the same conditions which operate in the case of the fecalith: a patent opening and lessened expulsive power.

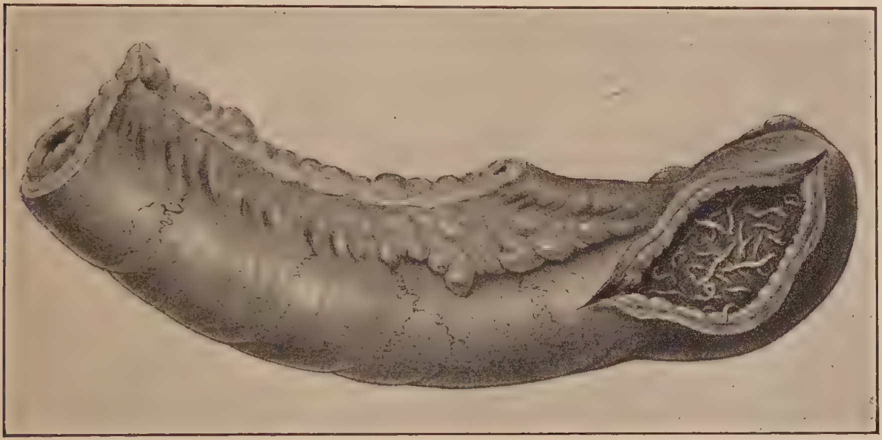

FIG. 11.—APPENDIX CONTAINING OXYURIS VERMICULARIS. (Courtesy Astley P. C. Ashhurst.)

Obviously the frequent appearance of certain parasites in the appendix must occur in patients who reside in tropical or semitropical regions. But other worms are common to any clime or country and they may have to be reckoned with as etiological agents.

Most interest has seemed to center around the *Oxyuris vermicularis*, or thread-worm, a widespread intestinal parasite. It has been held that these worms are bred in the cecum and enter the appendix directly, producing definite lesions and even invading the appendical wall. There is a wide difference of opinion in regard to the causal agency of these worms. They are found largely in the intestinal tract of children, but more often in adults than is thought, and their presence in the appendix might be regarded as coincident; but it appears from numerous reports that there is a specific etiological connection between the worms and the lesions. Generally the parasites are overlooked, because of their small size or because they are not suspected (Fig. 11).

For over twenty-five years medical authors have discussed pro and con the oxyuris as a direct or indirect cause of appendicitis. Eastwood examined seventy-three appendices removed at operation from definite cases of appendicitis, along with fifty normal appendices from the autopsy room. In the former series the oxyuris was found in 19.2 per cent and in the latter 28 per cent—that is to say, somewhat more frequently in the controls. They appeared much more often in the cases of both groups under fifteen years of age and no evidence of intramural burrowing in the appendix was seen. He also investigated the eosinophilia in the appendix wall with relation to the presence of oxyuris in the lumen, an analogy with the local eosinophilia produced by the *Trichina spiralis*, suggesting that the oxyuris if sufficiently pathogenic to produce burrows might also cause a local eosinophilia. The findings from cell counts made on sections of both normal and diseased appendices, proved that eosinophils existed constantly in the appendices of both groups, usually beneath the epithelium, and, although they were considerably increased in number in the cases of inflamed appendices, this increase was entirely independent of whether the appendix carried oxyuris or not. Boyd deems it impossible to explain the significance of these eosinophile collections in chronic appendicitis, but raises the question of their relation to the esinophilia found in the inflammatory swelling of the mucosa in bronchial asthma.

Portley feels that though the oxyuris gives rise to all the symptoms of appendicitis, yet it is no true appendicitis, but a condition closely allied to it. From long experience Dudgeon and Mitchiner, although recording one instance out of twenty-five cases of acute appendicitis in which they found thread-worms, do not believe that the oxyuris is a frequent cause of appendicitis in England. Fischer observed from one to twelve specimens of oxyuris in 110 operations for appendicitis and in 28 per cent of general autopsies. He discovered no evidence that they produced the acute suppurating types.

Credence is given by Short to the oxyuris as a true cause of appendicitis when he advises the operator who is chagrined over his diagnosis to examine carefully the interior of the appendix for thread-worms. He recalls that on fifteen occasions he had operated on a diagnosis of acute appendicitis and removed an apparently normal appendix, only to find that in each instance it contained oxyurids. In his experience the neighboring lymph-nodes usually are enlarged and he believes the pain, fever and vomiting are due to the presence of the worms.

Selman operated upon a girl eight years old who had abdominal pain and tenderness with a temperature of 104½° F., but no nausea or vomiting. The appendix was 3 inches long and contained oxyurids with ova in its lumen.

Other reports upon the *Oxyuris vermicularis* in the appendix may be mentioned. Drüner examined 172 appendices of which thirty-six (22.6 per cent) contained oxyurids; twenty-four were male and twelve females. Only one, a girl, was under fourteen years. Noack's article gives a detailed report of fifteen cases of appendicitis operated on in the acute stage or during the interval between attacks. Seven of them were acute and three of them were in children aged two and seven and nine years respectively. All of the cases showed the parasite free in the lumen or embedded in the wall. Rogers suggested that in intractable cases of thread-worms a nidus may exist in some part of the alimentary canal not easily reached by ordinary treatment, and recorded a case to illustrate this point. It was a man of eighteen, single, who suffered from thread-worms since childhood. Anthelmintic treatment was of no avail. Thinking the appendix might be the source, operation removed a retrocecal, fibrous appendix through the usual muscle-splitting incision. On taking off the clamp from the base of the amputated appendix thread-worms crawled out of the lumen in great numbers. No further parasites appeared since operation. No doubt other cases of this nature occur, a focus of nematode infection existing either in the appendix or saccule of the colon.

In the year 1923 an editorial in the *Journal of the American Medical Association* (80:256), entitled, "Intestinal Worms and Appendicitis," noted the very great emphasis placed by European surgeons upon foreign bodies and especially intestinal parasites, in the causation of appendicitis. Rheinford's conclusions are given indicating the oxyuris as an important agent in bringing about the disease upon histological examinations of the mucous membrane. Other authorities are mentioned to give weight to the rôle played by parasites: that there are few persons who have not harbored these worms at some time during their lives (Stiles); that "far more cases of appendicitis are the outcome of injury done by worms than is usually supposed," and that the worms which started the inflammation may have disappeared before the time of operation (Chandler); that appendicitis is a much more common disease now than it was when "worm medicine" was freely administered.

In the next issue of the *Journal* Ravenel recalls the work of Metchnikoff and stresses the lack of attention devoted by American surgeons, pioneers in appendicitis, to intestinal worms as strong factors in producing the disease. He even draws an inference that appendical infestation by worms is communicable, citing Metchnikoff's records to show contraction of the disease by a man from his wife by means of parasites and the widespread attacks of appendicitis among family, visitors and servants on a large estate through the contamination of the blood by feces containing worms.

To all of which it may be said that intestinal parasites can and do give rise to injuries of the mucous lining of the appendix, and thus may determine inflammation in this vestigial structure. The question comes down to the relative frequency of the worms and the type of disturbance which they produce.

More recently Harris and Browne in an extensive study of twenty-two appendices infested with *Oxyuris vermicularis* out of 121 cases operated upon, conclude that the pathologic condition of the specimens demonstrates conclusively the causal rôle of these worms in appendicitis, that the failure to recognize the oxyuris as a factor in producing appendicitis is due to a lack of detailed study of the vermiform appendix, that in all chronic recurrent cases of appendicitis the oxyuris should be considered as a likely cause and the whole subject be studied in detail.

We have noted the oxyuris in one case and the worms appeared to be the only pathologic factor at hand.

Next in importance the *Ascaris lumbricoides,* or round-worm, may receive attention. The literature contains a number of case reports going back to 1820. Most frequently the worms fill up the appendix and, if long enough, project into the cecum; or they may perforate the appendix and appear in the peritoneal cavity, with or without abscess formation. An interesting case is reported by Portley, who states that parasitic infestation of the appendix is extremely rare in Ireland. His patient was a boy of four years, with a facies suggesting tuberculous infection, admitted as a case of acute appendicitis. At operation the mesentery was found studded with tubercles and a small amount of pus was in the right iliac fossa. Wandering free in the cavity was a lumbricoid worm 6 inches long, which had escaped through an opening in the tip of the appendix. There was no great inflammation of the appendix, no acute peritonitis; evidently the ascaris was a recent arrival in the cavity. Two reports demonstrate a like occurrence in instances of the sort—the discovery of lumbricoids under dressings or in the incision subsequent to operation. An occurrence of this sort was observed by Col. Henry Page in 1898 during the course of an operation on a Filipino lad. Opening the abdomen he came at once upon a large indurated mass in the right iliac fossa. As it was impossible to open or loosen it without danger, the incision was packed. Next day a large number of round-worms was found crawling under the dressings. Robertson treated a Korean baby of twenty-seven months whose appendix, perforated with abscess, was removed and next morning an ascaris was found in the dressing. Cook and Tasker's case was that of a girl of twelve years operated on for appendicitis, the incision drained by a rubber tube. No worms were seen at operation and none thought of. Four months later through a persistent sinus five ascarides were discharged at two-day intervals, coming presumably through the stump of the appendix.

No ascaris in the appendix has been observed in our practice.

The *Entamœba histolytica* is a rare finding in the appendix. Hogan's case resulted fatally on the seventh day from a perforation of the cecum.

Bilharzial appendicitis is described by Pirie as being more common than is usually considered. First he quotes Turner who pointed out that deposits of schistosome ova are frequent in the appendices of African natives coming from the east coastal regions, but there is no evidence that symptomatic appendicitis is prevalent among them. In twenty-seven unselected necropsies of such natives he discovered twenty with ova in the appendix. Pirie, on the other hand, examined the appendices sent to him after removal from various parts of South Africa during the five years, 1918–1923, and found twenty appendices more or less heavily infested with bilharzia ova and in all but one the ova and the structural changes produced directly by them appeared to be the sole lesion and presumably, therefore, the cause of the symptoms which had led to the removal of the appendix. In the one exception the appendix was the seat of a fulminating hemorrhagic almost gangrenous inflammation, obviously an acute condition complicating the underlying chronic bilharzial lesions.

Leishmaniasis of the appendix is a very infrequent manifestation. Hartman-Keppel during a sojourn in northern Syria, saw many cases of the disease, but only one in which the appendix was involved. The patient, a woman of twenty-seven years, had the cutaneous form of leishmaniasis since early childhood; for the past nine months she had intestinal disturbances. After a full meal she had violent sudden pain in the epigastrium with vomiting. Operation revealed the appendix in the retrocecal position, bound by adhesions, not perforated; omentum, cecum and small bowel adherent to the anterior abdominal wall. The appendix was studded with the Leishman bodies and the characteristic lesions were reproduced by inoculation of a dog.

Various other parasites have been seen in the appendix at operation. Among these are the tapeworms, the tricocephali, the echinococcus, the *Amœba coli,* all extremely rare occupants of the appendix. American surgeons working in the tropical belt have recorded cases. In 1916 at Panama special examination of West Indian Negroes, recently dead of appendicitis, showed that fifty-one of the appendices contained parasites—tricocephalus in twenty, uncinaria in nineteen, entameba in twelve. Here again we may ask whether these parasites are cause or coincidence.

The greater frequency of chronic appendicitis in tropical regions is attributed by Marulanda to tricocephali. In twenty cases he found these worms sixteen times, anchored deeply in the mucous folds by their sharp-pointed extremity. He regards the tricocephalus as a provocative cause of appendicitis, producing abrasions which lead to infection.

Foreign Bodies.—We have considered intestinal parasites and fecal concretions in separate sections, since we regarded these more or less as already residing within the body. Though they are not normal inhabitants, yet the concretions are formed within the appendix and the parasites are simply transferred from one area of the intestinal tract to another. What we shall refer to now as foreign bodies are those substances which come from without, are taken into the body either by design or accident, and find lodgment in the appendix. That they damage the appendix, cause inflammation and perforation cannot be doubted. Whether in any given case they actually cause appendicitis is a question. They may be found incidentally without any premonitory signs of their presence. On the other hand they may produce immediate, acute and alarming symptoms as soon as they locate, or pursue a slower, but none the less surer, course of events.

On the whole the discovery of a foreign body within the appendix vermiformis is a rare event. Things which resemble them are found every now and then; witness the common reports of cherry stones, grape seed and other extraneous substances formerly made only to be revealed in the majority of cases as coproliths, previously referred to. The fear of eating seeded fruits on account of acquiring appendicitis is still fresh in the minds of many physicians and laymen at the present time. These seeds were found in the appendix, though extremely seldom, and in a few instances did set up the inflammation. This observation still applies, only we now are able to discriminate and to analyze more clearly the relation of foreign bodies to the origin of appendicitis, not that we are any more competent in certain types to distinguish between those in which the foreign body may act as a remote or an immediate cause.

It will be remembered that the very first recorded account of a diseased appendix (Mestivier) presented a foreign body—a large pin—in its lumen. From that time up to the present hundreds of extraneous substances have been described as found in the appendix. Reports seem to have appeared in waves; some surgeons have come upon them frequently, while others find them rarely and still others not at all. A recital of them all would fill up much space with little to gain from such study. Various and sundry articles are on the list, the most notable are pins, fishbones, seeds, shot, hairs, bristles and hulls of nuts. Sharp-pointed bodies and those having weight are especially liable to slip into the lumen of a patent appendix. When the fetal shape persists, the funnel type, cecal contents find ready access downward and foreign bodies of higher specific gravity than the normal feces tend to remain. The kind of extraneous material left in determines to a great degree whether it shall be regarded as an activating cause of appendical mischief, or merely as an incident. Pointed bodies may give rise to perforation, leaden shot to pressure necrosis, bristles to irritation of the mucous membrane.

Up to 1904 some fifty-six reports of a foreign body in the appendix had appeared. A great many more have been published since. During the past five years several unusual instances have occurred. Spence found thirty-seven whole rabbit shot in the appendix of a woman servant whose diet was largely of rabbits; and Hall obtained twenty-one shot from an appendix discovered by the roentgenologist before operation in a male patient, also a large consumer of game.

Other cases showing shot in the appendix in patients who were ardent hunters and eaters of game have been noted by Esau, who found thirteen shot in an appendix firmly adherent within a hernial sac; by Schroeder, who extracted twenty-six shot from the distal third of an appendix down in the pelvis, but nonadherent; and by Eckert, who found one shot encased in a semisolid fecal concretion.

Upton observed a man of seventy-nine years who swallowed a tooth and about six weeks later came down with a right inguinal hernia, which at operation revealed a sac full of pus containing the tooth and the remains of a sloughed appendix high up at the internal ring. A similar, but even more unusual instance is reported by Langley. A man of sixty years swallowed a nail two years and eight months before coming to the hospital. He felt it protruding into the scrotum on the right. The next day when he returned to have an operation performed, the nail had dropped back into the abdomen and the x-ray showed it to be in the right lower quadrant. The patient also had a right inguinal hernia and when operation was done, the appendix and its mesentery were found within the sac; the nail was in the cecum but readily slipped into the appendix. There was no perforation in the cecum or the appendix, and no inflammation was manifest. Fifteen oxyurids appeared in the lumen of the appendix. Langley concluded that the nail probably perforated the cecum while in the hernial sac and disappeared on spontaneous reduction.

This was a case, then, in which the foreign body did not seem to produce inflammation of the appendix, but rather to give rise to symptoms through its mechanical interference and desire for a proper exit.

A more refined article of hardware was discovered in a patient of Kelling's, who swallowed a small screw, but felt no disturbance until eight weeks afterward. Then symptoms of acute appendicitis came on suddenly. Operation three days later showed the appendix inflamed and thickened but without adhesions and the screw at its tip with the pointed end downward.

There seems to be no good reason why rough parts of foodstuffs are not more commonly caught in the appendical lumen and brought to light at operation. The only foreign bodies ever encountered in my clinic were, in one case, a piece of chewing gum and in another the inside lining of an apple core. Both of these materials were proven by tests. Eick asserted that the seed of the corn flower (Centaurea) found by him in many appendices may be the cause of appendicitis. These seed and the bristles which accompany them may be mixed in with the rough meal, or taken into the mouth and swallowed during threshing. Niedemeyer discusses this phase of the etiology and suggests that injuries from foreign bodies might play an important rôle in producing appendicitis in addition to the causes acting through the blood stream or by bacterial invasion from the intestinal tract. He records a case of his own, a farmer boy of twelve years, operated upon a few hours after the onset of symptoms of appendicitis. The appendix on removal was inflamed and its wall showed purulent infiltration and embedded in it was a grain of rye, verified by the microscope.

Quite remarkable was a case in the practice of Mülleder. A man forty-three years old with general abdominal pain and vomiting was admitted upon a diagnosis of appendicitis. Two years before he was thought to have had gastric ulcer and a complete roentgenologic examination was made. Operation revealed an inflamed appendix which contained a whitish yellow calculus of bismuth.

Here is an unusual case recorded by Jones: An old man of ninety-three years presented symptoms of acute intestinal obstruction, with irreducible swelling in his right groin. Thirty years before, while lifting a barrel he had been "ruptured." The hernia was reducible until the day preceding entry into the hospital. Operation showed indirect inguinal hernia with the sac containing the cecum and inflamed appendix. Removal of the constricted pressure from the neck of the sac caused the color of the bowel to change from purple to normal. Appendicectomy was done and the bowel returned to the abdominal cavity. The wound healed by first intention and he recovered completely. The appendix was thick and long. The lumen contained fecal matter, and in the tip there was a fishbone attached to the distal end.

In the cases of three boys, with typical overlapping attacks of appendicitis, without increased leukocyte count, Milano found in each the appendix dilated and containing foreign bodies. One contained a raw bean; in the second there was a shot forming a nucleus for a fecal concretion; in the third the appendix had ruptured and from it were escaping a number of grape seed and purulent material.

Upon appendicular foreign bodies in general, and pins in particular, Mahoney has presented a paper, which may be reviewed for the closing of this section. His study was stimulated by the fact that he operated on a boy of four years who had developed acute appendicitis. The presence of a pin in the lumen of the appendix was not discovered until the end of the operation, when the specimen was opened. The pin lay parallel to the long axis with its point towards the cecum and its head at the tip. The shaft of the pin was surrounded by a hard fecal concretion the size of a peanut, with the point uncovered ready to start something at the earliest possible moment. The duration of time that the pin was in the appendix is open to conjecture. From the thick walls of the specimen it must have certainly been there for a very long time, evidently from the creeping period of the boy's life, about three years before. In his article Mahoney presented from the literature an account of seventy-four cases of true foreign bodies of which forty, or 55.5 per cent, were pins. A summary of his findings may be stated as follows: Pins are the most frequent of foreign bodies found in the appendix. Pins occur more often in males than in females (2:1) and most frequently in children under ten years. Such cases are comparatively rare, only forty pins in 160 years, possibly 228 years, if the case of Ruysch (1691) is considered the first case. Only eighty-six cases of true foreign bodies are mentioned in the literature. They range from 0.2 per cent to 12 per cent among American observers. The percentage is higher among foreign authors—as high as 50 per cent, probably due to the fact that these writers classify fecal concretions as foreign bodies. The pin generally lies quiescent a long time, but the attack causing operation generally is acute. The mortality is exceedingly high. Pins may enter by head or point and lie transversely or parallel to the axis of the appendix. The appendix generally is perforated and with the point of the pin; for the pin is usually covered with deposit and the point left free. No history of swallowing the pin is given, as a rule. Abscess formation usually is present and before the year 1895 the mortality is extremely high. Metastatic abscesses of the liver are rather commonly present.

As an adjunct to these observations may be mentioned an unusual case which came under the care of Carones. A boy of seventeen had symptoms leading to a diagnosis of acute appendicitis coming on one year after swallowing a pin. At operation a small abscess was found in the ileocecal area, while the appendix was normal, but a pin protruded by its point through the posterior wall of the ileum near the ileocecal valve with its head still in the intestinal lumen.

In 1924 Mather recorded the case of a woman who had been operated upon for the relief of right abdominal pain, supposedly due to a "misplaced womb and enlarged ovary." The pain still persisted after two years, Roentgen-ray pictures demonstrated a pin in the right lower quadrant, diagnosed as in the appendix. Operation revealed the pin with its head in the lumen of the appendix and its point sticking through the appendical wall into the iliacus muscle.

Trauma.—As an exciting cause of appendicitis injury is deserving of serious consideration. Surgeons of large experience have observed too many instances of the close sequence of the disease following after different kinds of injury to permit them to ignore this association of events. Caution will suggest, however, that the *post hoc ergo propter hoc* idea be avoided. Appendicitis is such a universal disease and accidental injuries so common that the one may not be related to the other except as a coincidence. It is very difficult to be sure of the premises or to draw proper conclusions.

Far back in the history of appendicitis the influence of trauma was recognized. In 1830 Goldbeck reported the case of a boy of ten who fell from a wagon and eight days later began to complain of pain in his right abdomen and the other signs of acute appendicitis. He died a few days later and the autopsy showed a perforated gangrenous appendix, containing a coprolith at its tip. Kelly includes this case in his summary of fifty reports from the literature up to 1905, and insists "that the number of cases in which appendicitis is associated with injury or violence is much greater than is generally credited." Very wisely, however, Kelly advises not too rigid acceptance of the patient's spontaneous suggestion of a causal injury and warns the medical attendant to be guarded in his inquiries so as not to insinuate that trauma may be the responsible agent in appendicitis.

It is debatable whether the appendix can be injured directly by a blow from without. This is granted as possible; but it is somewhat doubtful, unless the organ be lying across the pelvic brim or upon the posterior wall where it might be impinged between the force in front and a resisting structure behind. Most probably the trauma may result in increased pressure within the appendix, just as the small intestine can be injured by a severe blow on the abdomen, giving no outward sign of contusion. To explain this in relation to the appendix it has been suggested that the abdominal wall is not to be regarded as a solid body, but subject to laws governing liquid and gaseous media. To attest the relation of injury it is not necessary to show blood in the peritoneal cavity, or histological evidence of direct trauma, but only the invasion of the appendicular wall by rupture of the mucous membrane (Ludington). Forms of injury usually connected with the subsequent occurrence of appendicitis are blows, falls, heavy lifting, severe strains, etc.

Of late years by far the most interesting report on this matter is that of

Ludington. He treats the subject in two parts: One having to do with the question whether an injury can initiate original inflammation in a previously healthy appendix, and the other whether it can light up an acute exacerbation of a previously existing inflammation. That trauma does not start primary disease in a healthy appendix, all are agreed, but upon the second question there is much divergence of expression. If the appendix has been damaged by previous infection resulting in the formation of coproliths, of fecal stasis or of adhesions, Ludington holds in common with other observers, that mechanical injury will serve to excite an acute attack of appendicitis. In the report of his clinical cases to prove the rôle of trauma, all three of them occurring in young subjects (nine, ten and nineteen years respectively) the history in two does not state whether the patients had previous attacks, while in one case at least (the older of the three) a saline purge had been administered and the only source of trauma was "conscientious deep palpation" by the examiner's fingers. Ludington quotes Osler as saying in 1899 that "trauma plays a very definite rôle, and in a number of cases the symptoms have followed very closely a fall or a blow."

Upon Ludington's paper and Osler's opinion the Supreme Court of the State of Washington held appendicitis to have been caused by a blow. The patient in question was struck on the right side of the abdomen by a wooden block thrown from a saw, complained of immediate pain and nausea; considered the next morning to have appendicitis, but not operated upon until the eleventh day, when the appendix was found "three times the normal size, with reddened veins." The court below found that the injury caused the appendicitis and adjudged the patient entitled to compensation. An appeal was taken and the higher court sustained the judgment. Thus the relation of trauma and appendicitis may assume very important medico-legal significance. It is much the same as the matter of hernia and injury. We are treading on dangerous ground in attempting to interpret the inner effect of external violence, when we know so little of possibly preëxisting conditions. One cannot help believing that in the case of so-called "traumatic appendicitis" there must be previously present some pathological state of the appendix which might be brought into activity by outside injury, just as it could be done within by an overfilled cecum, faulty posture or the presence of concretions; or mayhap the affair might be wholly independent of the blow or fall—likely enough to happen at any time without such accident.

An illustrative instance came in my own practice. Twenty-four hours after playing in an important football game a young man was admitted with a gangrenous appendicitis, which was attributed to an injury received during the play. He became dizzy and nauseated and came out before the game was finished. I was present on the side line, noticed the boy as he first ran on the field at the head of his team and remarked that he looked pale and hollow-eyed. I was told that he had spent the previous night at a country hotel where he ate some sea food which did not agree with him and gave him "ptomaine poisoning." His playing throughout was rather under his usual form and I felt suspicious that there was something deeper in his case. It was no surprise, therefore, to have him turn up twenty-four hours later with a ruptured gangrenous appendix. My impression was then, and has so remained, that this boy's attack of appendicitis began the previous night, that it continued during the game aggravated by the exertion, and that it culminated in the gangrene as observed at the operation. This course of events undoubtedly takes place in many cases; surely some of them would occur without exertion or injury.

Trauma and appendicitis were discussed by three observers in the *British Medical Journal* during 1923. Smith reported the case of a girl of nineteen who tripped over a stub in a field and fell flat on the ground but not on the projecting object. She felt sick and faint, soon improved, went home, ate supper and slept well. Next day the pain set in and continued more or less intermittently and severer until the third day when all symptoms of appendicitis presented. Operation showed a localized appendicular abscess shut off from the peritoneal cavity by strong adhesions. Also he cited the case of a man of fifty-nine who, standing astride a wooden pole, slipped and fell, his whole weight coming at the lowest part of abdomen. On the fourth day he was operated on. The abdominal cavity was filled with foul-smelling pus from a gangrenous, perforated appendix. Wild recorded this case: A boy was struck in the abdomen by a perambulator three days before. Symptoms of appendicitis set in soon after the injury. Operation on the fifth day showed a gangrenous appendix. A young clerk attended by Sabawala was hit by a ball over the right iliac fossa while playing hockey. Admitted to hospital the next day with a typical attack of appendicitis, he refused operation at first, but submitted to it a week later. The cecum and terminal lumen were found matted into a hard lump with the tip of the appendix projecting about the middle. The appendix was removed. On cross examination it was learned that about a year previously he had a spell of "indigestion" lasting only overnight.

A rather unusual example of the possible effect of trauma is exhibited in the case reported by Wagner of a professional baseball player who was struck in the abdomen by a very hard hit ball two weeks before admission. He fell to the ground, retired from the field, played the next day, but was very sore over the whole abdomen. Two doses of castor oil were given him a week apart. Sent in for acute appendicitis, he was kept under observation and operated about a week after admission. The appendix was found normal in appearance but there was an indurated mass at the ileocecal angle, which proved to be acutely inflamed mesenteric glands. Wagner believes the injury produced inflammation of the cecum and that this in turn gave rise to the mesenteric lymphadenitis. His pathologist could not "state definitely origin as traumatic."

Two instances cited by Taylor furnish occasion for comment. The first, a young man of eighteen years, received a blow on the abdomen from an opponent's elbow, and was laid out for the moment with vomiting; later abdominal pain, temperature of 100° F., pulse 88, abdominal tenderness and rigidity. Operation next day revealed an acute appendicitis. On cross examination after operation the patient stated that some two months previously he had suffered from an attack of "indigestion" (pain all over the abdomen and vomiting) which lasted two days, and then cleared up. He was positive that when he walked on the football field he was feeling entirely well. The second case was that of a male, twenty-three years old. He was working in a pit and had put forth a violent effort to lift a tub on to the rails. Three minutes later he was seized with a sudden acute pain across the lower abdomen and vomited. On the evening of the second day operation was done and an acutely inflamed appendix was removed. In both of these cases the attack, as Taylor states, was definitely ushered in by violence; in the one by a direct blow on the abdomen, in the other by a severe strain. An intriguing point in both cases is their bearing on the Workmen's Compensation Act. In the first case, of course, that question did not arise, but supposing it had, compensation could not have been withheld, even allowing that the patient had had a previous attack, the onset being apparently so definitely the result of the blow. In the second case the influence of trauma is more debatable.

Fotheringham reports the following case as one of "traumatic appendicitis": A young girl of fifteen years, making a sudden turn, fell against a wall, striking the left side of her abdomen. This was followed by severe pain which forced her to rest in bed on the right side with legs flexed. Seventeen hours after the accident she presented peritoneal facies, with a temperature of 102° F., pulse 140, no visible external marks of injury. Laparotomy showed general peritonitis with free seropurulent effusion. The appendix was removed, a drainage tube inserted and antigangrenous serum (Pasteur) given. She did well up to the eighth day, when the abdomen became distended, and severe pain and high fever followed. On opening the abdomen in the median line the intestines were found agglutinated at the bottom of Douglas' sac, with a large amount of feculent yellow pus which was removed. She had a slow but complete recovery.

Perforation of a healthy appendix after trauma is seen in a case reported by Gutzeit. A boy aged fourteen years was kicked in the abdomen by a horse and immediately developed symptoms of peritonitis. Operation showed perforation of the appendix, an opening the size of a pea, as the only intestinal lesion and an otherwise healthy appendix, from which he had had no symptoms before the accident. Gutzeit says it is not to be regarded as a traumatic appendicitis.

A very recent occurrence in my practice serves to emphasize the obscure claims often offered in support of trauma as an activating cause of appendicitis and the slipshod methods of reasoning that might be indulged in concerning the related events. Two boys, one white and one colored, both about twelve years old and constant playmates, were brought in for operation within three days of each other. In the former (Clifford C.) was found a gangrenous appendix unruptured (Fig. E and EE, Plate II); in the latter

(Boyd W.) an acute gangrenous perforated appendix (Fig. F, Plate II). Four days previous to the first admission both boys had attempted to harness an unruly mule and became exhausted after violent struggling over their unsuccessful efforts. The next day both boys were seized with acute abdominal pain and all the symptoms of well-marked appendicitis. The white boy came to the hospital earlier, his incision was closed without drainage; the Negro boy's abdomen was drained through a stab wound. Offhand one might be justified in concluding that the exertion by the boys had much to do with their attacks of appendicitis, but neither they nor their families attributed the disease to harnessing the mule, and it was mentioned but incidentally afterward. Just as much importance has been attached to injury as a probable cause of appendicitis in many cases showing no closer connection than existed in the dual occurrence here related. Ever to be kept in mind is the word, coincidence.

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CHAPTER V

PATHOLOGY

In the foregoing discussion of the causes of appendicitis it has been difficult to avoid references to the pathology of the affection. So closely, indeed, are causal agents related to the pathological conditions that the etiological factor may determine the type of the morbid findings. For instance, the disease changes in an appendix infested with intestinal parasites would be different from one invaded by anaërobic organisms. It is our purpose, therefore, to review the etiology as it concerns the pathology of the appendix. Our main divisions will include, first, the pathogenesis and, second, the morbid anatomy.

PATHOGENESIS

Just how the determining causes act to bring about inflammation of the appendix in any particular instance is not readily explained. According to the nature of the exciting agent the mode of infection and the type of pathology will vary. Different pictures are presented, for example, in appendical inflammation due to direct microbic invasion, to the influence of infectious diseases, to the presence of foreign accumulations.

As we have pointed out, the indispensable factor in true appendicitis is the presence of bacteria bottled up in the lumen of the appendix or enmeshed within its walls. In either event the organisms attack whatever tissues they may locate in and proceed with their life course as they would in any other part of the body. All are agreed that, when bacteria enter the appendix through its cecal opening, from some predilective cause or from lowered resisting power of the local cells, their first onslaught is upon the mucous membrane lining the appendicular canal. The reaction and its results are here similar to processes elsewhere in the body; for the pathology of one mucous membrane is the pathology of all. The morbid changes produced will depend upon the conditions controlling the usual contests between microbes and cells, *viz.*, attack and defense, virulence versus resistance. Upon the consequence of this warfare will depend the pathological and clinical varieties of appendicitis to be described later.

Not all are agreed, however, upon the hematogenous origin of appendical infection. There seems to be no sound reason why, as in other structures of the body, bacteria should not be conveyed to the tissues of the vermiform appendix by the blood stream. In our discussion of the etiology it was shown that appendicitis could be regarded reasonably as a local expression of a general infection, as for instance, in influenza. In that special condition, however, the appendical infection might be direct from the effect of the disease upon the local mucous membrane of the cecum and also the appendix. This was mentioned previously. At all events, that microbial inroads of the appendix can occur through the circulating blood many investigators believe. Kelly quotes Adrian as having produced "appendicitis by injecting suspensions of bacteria into the ear vein of the rabbit" and demonstrating microscopic lesions "in the mucosa of the appendix before either gross or biologic changes could be detected in other portions of the intestine." Adrian also claimed to have found the influenza bacillus in an abscess around the appendix, but in the absence of proof in the properties of this organism, Kelly suggested further investigation. We now know, of course, that this bacillus is not the actual or the only microbe associated with influenza. Most authors at that time (1903–1905) did not consider the testimony sufficiently sound to warrant belief in the etiologic relation of appendicitis and general infections. The work of Rosenow extending over a period of years (1915–1921) tends to prove the blood-borne origin of appendicitis along with a similar process of infection in other organs—a phenomenon depending on the elective localization of bacteria. His experiments demonstrated that "intravenous injection of streptococci, and in some instances of colon bacilli from acute appendicitis has been followed by marked . . . lesions of the appendix of rabbits, whereas attempts to produce appendicitis by way of the mucous membrane have been unsuccessful unless the blood supply is markedly interfered with." This seems not only to confirm the possibility of infection by the blood stream, but also to settle the point that some break in the mucosa or injury to its cells is necessary for the initiation of the disease through the lumen. Rosenow further felt that hematogenous infections of the appendix usually were carried from a chronic focus elsewhere in the system. His evidence also included clinical reports showing acute attacks of appendicitis following exacerbations in sinuses, teeth and tonsils and in addition streptococci with affinity for the appendix in the tonsils while both infections were present or following close upon each other as well as their absence when the attack had subsided. Our experience corroborates these observations. Rosenow's investigations indicated "that the colon bacillus is usually a secondary though important invader" in appendicitis, a conclusion not in accord with the opinions of others, who have studied the bacteriology of the morbid appendix.

It must be admitted that the appendix can become affected through the blood from a distant focus in the body. Conversely the appendix may act as a focus itself, being the source of infection in other parts, as will be described under complications and sequelæ.

Such a view is advanced by Binet who admits that general infections are exhibited in the appendix, but believes that if bacteria pass from the circulation to the appendix, there is also a current in the opposite direction. He quotes Masson and Regaud, who found that in the rabbit the bacteria penetrate the appendicular lymphoid tissue toward the end of the second week of extra-uterine life and at the end of the fifth week have reached the middle portion of the fundus of the follicles.

There are not wanting some authors who fail to endorse blood-borne appendicitis. Notably Warren speaks of early appendicular lesions occurring at the margin of the lumen (enterogenous); further he observes that the inflammatory reaction is not different with the different organisms, except that it is more hemorrhagic with the hemolytic streptococcus. He has not found Aschoff's Gram-positive bacillus in lesions of the appendical wall and only rarely in the contents of the lumen. In just one case, however, that of a girl of five years, he recovered the pneumococcus Type I, from a periappendicitis, followed four days later by lobar pneumonia, also Type I, a possible demonstration of Binet's reversal flow. But Warren states positively that the bacteriological and histological evidence is all against a hematogenous origin of acute appendicitis.

Hematogenous, or metastatic, infection is not denied by Fischer, but practically, he thinks, it does not play an important part. In general infections with streptococci or staphylococci, says Fischer, emboli occasionally occur in the mucosa and submucosa of the appendix; this process is not confined to the appendix, but is associated with lesions of other parts of the bowels. Inflammatory reaction is absent in the tissues surrounding such embolic foci and the picture of acute appendicitis is not produced there. According to Fischer the blood-borne theory is defended by Breitzke, who claims that in anginous and other infections germs enter the blood stream, are attacked by the phagocytes, but not killed, and are then deposited in the bowel, at such sites where there is a marked irritation. If there is a stasis of the secretion in the appendix, these phagocytes are attracted to the point, where they have a suitable culture soil, and then pass from the lumen to the folds of the mucosa and the wall—a hematogenous transport—but still a penetration coming from the lumen. Fischer objects to the reference to a preceding angina; he regards this as a rare occurrence, arguing that if this association constantly existed, we would more often observe appendicitis in scarlet fever. And yet though admittedly uncommon, published reports seem to indicate an increasing number of appendicitis attacks occurring as complications or sequelæ of scarlatina. Further reference to this will be made in the clinical sections of this monograph.

Bacteriology.—When we come to consider in the light of pathology the actual causal factors and how they bring about what we recognize clinically as appendicitis, together with the diseased changes which appear in the appendix itself, we must again assert that the primary and constant agent is bacterial infection. But, as pointed out previously, there are many subsidiary factors and various types of organisms to be reckoned with. And hereupon arise several interesting questions. Just how do the germs produce appendicitis? Are the ordinary bacteria normally found in the intestinal tract the guilty parties? Have they the power to, and do they, take on increased virulence and become pathogenic? Or does the infection come from pathogenic bacteria originating outside the intestinal canal? Most authorities concede both views to be correct: that outside bacteria may gain entrance and cause the infection and at the same time that the germs naturally resident in the intestine may be excited into pathogenic action by the foreign bacteria or by other intrinsic and extrinsic factors. A pathological analogy is supplied in puerperal infection and in pneumonia, both of which demonstrate the relations of bacteria normally habitant and those brought from other parts. The behavior of the colon bacillus is well known—its tendency to remain innocuous unless disturbed. There are other bacteria indigenous to the fecal canal; many others still are disclosed in inflammation of the appendix which are not found in the intestinal tract under normal conditions. These are sometimes concerned in the infection.

Besides the ordinary pyogenic bacteria and certain specific germs previously mentioned, there are less common forms, as the pneumococcus, *B. pyocyaneus, B. proteus vulgaris, B. lactis aërogenes,* and *B. fæcalis alcaligenes;* among the anaërobes occur *B. fragilis, B. ramosus, B. perfringens, B. fusiformis, B. furcosus, B. aërogenes capsulatus.* To the latter group Duthrie adds the *B. fallax,* which he found in three out of twelve cases of acute appendicitis, all gangrenous, and which organism he says, was first discovered by him in the human intestine.

The association of the various bacteria with different types of appendical pathology is interesting, but not absolutely constant. The colon bacillus, most frequent of all, usually accompanied by a mixture of organisms, but occasionally occurring alone, seems generally concerned with the less violent sorts of infection, and with those processes which do not become diffuse, but at the worst result in massive localized pus collections having a characteristic foul odor. Streptococci apparently are found in the very extensive infections, with spreading peritonitis and grave systemic signs; the severity of their lesions varies within wide limits. The staphylococcus and the pneumococcus are recovered chiefly from the yellow, creamy pus without odor (unless dominated by the colon bacillus) seen in the late cases or discovered in the mucous membrane or the contents of the lumen in cases associated with general infections. *B. proteus vulgaris* and *B. pyocyaneus* largely are derived by secondary infection.

Anaërobic organisms are supposed to be productive oı gangrene of the appendix and responsible for the high grade toxemia developed from such pathology. Without doubt these bacteria are more often present than is usually believed. In addition to reports given in the previous chapters it may be noted that Runeberg years ago found several kinds of anaërobic germs in appendicitis. In thirteen cases he detected the Gram-negative *B. thethoides,* first described by Veillon and Zuber; in nine cases the *B. ramosoides,* which is similar to the *B. ramosus;* and in six cases the *B. fusiformis.* In a further series of seven cases he found a fine Gram-positive rodlet which he named *B. anaërobicus alkaligenes.* The above-named streptococci have the identical properties of the *Streptococcus putridus* described by Schottmüller. They have the characteristic of developing in an albuminoid culture-medium with production of stinking gases having a typical odor. The colon bacillus in an alkaline medium may give rise to offensive odorous gases, but the pus never has the penetrating odor met with in the anaërobic streptococcus. Furthermore the important peculiarity of anaërobes is the tendency to thrombophlebitis. In pylephlebitis after appendicitis anaërobic streptococci are nearly always present, with or without the colon bacillus. The *B. coli*, is therefore, not the only element in causing the fetid odor in purulent appendicitis as is claimed by so many authorities. This analysis was taken from the paper of Brütt, who is of the opinion that in the majority of cases of such foul-smelling pus anaërobic bacilli are present and are the direct cause of the destructive pathological process and of the severe symptoms. Brütt's table follows:

Organism	Number of Cases	Mortality, Per Cent
Anaërobic streptococci plus B. coli.	45 (In 6 cases also Gram-positive anaërobes)	4=8.9
B. coli (pure culture)	36	2=5.5
B. coli plus aërobes	8	2=25
Other aërobes (pure)	3	0
Sterile exudate	15	0
TOTALS	107	8=7.4

Dudgeon and Mitchiner's bacteriological summary indicates findings somewhat at variance with other investigators. Their twenty-five specimens were studied in the first thirty hours of acute appendicitis. The common aërobic organisms isolated from the interior of the appendix were colon bacilli and streptococci, none of the former and only one of the latter being hemolytic. One anaërobe, the *Bacillus aërogenes capsulatus*, was found in five cases, four of acute appendicitis, and one a normal appendix; this germ was present with aërobes, but gangrene occurred only in one instance and the clinical condition of this group of cases was no worse than the rest. Tests made with anti-colon sera and isolated strains of the colon bacillus yielded positive results in one-half of the cases.

How, then, do bacteria cause appendicitis? The usual pathogenic course is, first an irritation or injury of the mucous membrane of the appendix by an extrinsic substance (concretion, foreign body, parasite) and second, the entrance of germs through this injured area into the submucosa, which initiates the inflammation. Cloudy swelling sets in, pressure of the blood-vessels causes slowing of the circulation in the muscular layer, the nutrition of the entire thickness of the appendix wall becomes impaired and finally death of the tissue results in gangrene. Irritation and bacteria produce the inflammation—and these are to be assumed in every case of appendicitis. But since the same conditions obtain in other portions of the bowel (which, however, are not supplied so generously with lymphoid tissue) without causing local infections and since fecaliths may exist in the appendical lumen for long periods with no resulting inflammation, there must, of course, be other factors, some of which were referred to in the preceding chapter.

Behan, who presents the above points, from his experimental work on rabbits, arranges these additional factors, with comments upon them as follows:

1. A fixed or abnormal position of the appendix in relation to the cecum and parietal wall, with associated bands or adhesions binding the appendix to surrounding structures, namely, the lateral abdominal wall, the psoas muscle, the cecum, the ileum, and the colon.
2. A disturbed blood supply, due to kinking or obstruction of the blood-vessels.
3. Dislocation of the cecum with distention of the cecal lumen and consequent traction on an adherent appendix.
4. Obstruction of the lumen of the appendix. This seems from experiments on rabbits to be the most potent factor in causing acute suppurative appendicitis or gangrenous appendicitis. (These experiments were incidental to other experiments on the production of intraperitoneal adhesions.)

He further states that obstruction may ensue when a foreign body is caught at the site of a previous constriction or when the swelling of the mucosa is sufficient to strangulate the circulation of the other layers, just as if a clamp were applied to the appendix. The more recent experiments of Heile resulted in the production of acute perforative appendicitis in dogs by ligating the appendix which contained material capable of undergoing decomposition. Positive results were obtained only if the dogs were overfed or diarrheic. Material which completely splits up was found harmless; amins of the protein-producing group cause the decomposition process and also the peritonitis which follows the perforation.

Reference may be made to intestinal parasites and the type of pathological appendix in which they are seen. In Pirie's article on bilharzial appendicitis he describes both the mild and the marked types of pathology. A lightly involved appendix he found of practically normal size but showing on the surface some small, white nodules, varying in size from those just visible up to 2 or 3 millimeters. These might be mistaken for tuberculous nodules, but they are harder and of a more porcelain-like glistening white than those of a true tubercle. These tubercles consist of connective tissue surrounding the bilharzial ova. In severe cases the tubercles may be very numerous, covering much of the surface of the appendix, especially tending to congregate near the distal end, and they are usually present also in the mesentery of the part closely adjacent to the appendix. In still more heavily infested cases the ova may be so abundant, and the amount of connective tissue so great, that the appendix is transformed into a thick hard mass, 2 to 3 centimeters in diameter, the meso-appendix sharing in the thickening. Even in such cases there are always visible, on the surface, some discrete "tubercles," which furnish a naked-eye clue to the nature of the thickening.

The continuing discussion of oxyuric appendicitis deserves some attention in respect to its pathogenesis. It appears that few morbid changes are to be found in the appendix infested by thread-worms unless other etiological agents are present. Jaroschka's chronic recurrent case, in a young woman of twenty-three years, had a large number of oxyurids in the lumen of an appendix which showed microscopically no inflammation of the mucosa, and the epithelium was intact. He concludes that these parasites may damage the mucous membrane of the appendix and produce toxic effects; that they often provoke clinical symptoms of acute inflammation, but that true appendicitis from oxyuris is much less common than is claimed by many authorities; that marked local eosinophilia is not frequent with oxyuris, but quite often a hyperplasia of the lymphatic apparatus. Eastwood again considers the arguments in favor of oxyuris as a cause of pathologic change in appendicitis, but still contends that oxyurids are not actually found more often in the diseased than in the normal appendix, and now casts some doubt upon the infestation being more common between the ages of five and twenty years. He is thoroughly convinced by the attitude of Aschoff, as expressed from his studies during 1913–1920. Aschoff denies that oxyuris had anything to do with the etiology, but says that in certain cases numerous worms in the appendix cause pain and symptoms resembling appendicitis, although on removal the appendix shows no inflammatory lesions. These cases he described under the name of "appendicopathia oxyurica." He urges that the appearance of oxyuris embedded or burrowing in the mucous membrane can be accounted for by artefacts produced in section cutting, the appendix being a difficult organ to obtain good sections from on account of the varying consistency of the different layers.

MORBID ANATOMY

Varieties.—Perhaps no sounder pathological classification of appendicitis has been offered than that of Fowler. While admitting that they could not always be separated clinically and that they graded into each other, he divided the stages as follows: (1) Endo-appendicitis, (2) parietal appendicitis, (3) periappendicitis, (4) para-appendicitis. We shall use Fowler's terminology, but employ our own description.

1. *Endo-Appendicitis.*—Endo-appendicitis, or literally "inside" appendicitis, expresses the idea of inflammation beginning in the mucous lining of the appendix. This inflammation is of the catarrhal type at first, as all inflammations are. It may subside at this period or it may advance slowly or rapidly to the other forms. There is no definite time limit; rapid infiltration can develop in a few hours, while it may require two or three days for the

inflammation to resolve or to progress. While confined to the interior of the appendix, the inflammation is not immediately dangerous; but it can produce pathological changes which may lead to perilous results, especially if it recurs after one or more subsidences. Some particular portion may be involved more than another and damage thus done to the mucous membrane encourages a further insult. Ulceration is thus induced with resultant perforation when the wall is penetrated. Stricture, with formation of fibrous tissue and bands, is produced after many attacks (Fig. 12). Gangrene supervenes if the swelling interferes with the circulation of the appendix. In other words this inflammation starting in the mucosa may quickly run into the second stage.

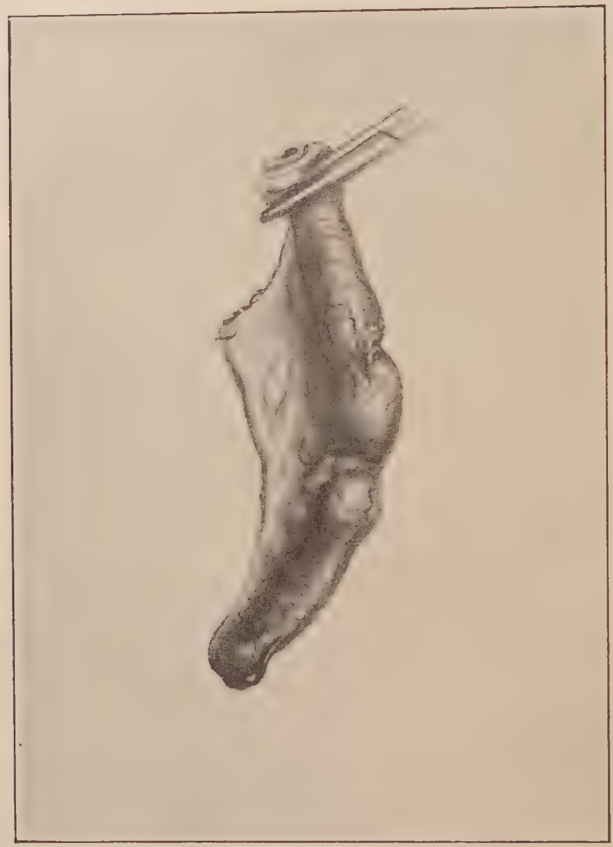

FIG. 12.—ACUTE APPENDICITIS WITH HISTORY OF MANY PREVIOUS ATTACKS.
Showing strictured portions almost completely severing the canal.

2. *Parietal Appendicitis.*—Parietal appendicitis represents the stage in which the inflammation is within the wall of the appendix. According to the view taken this may come from a focus of infection elsewhere in the body

by metastasis, or it may advance directly from the inner coat of the appendix. The latter process is the more common. There is swelling with marked congestion of blood-vessels and redness; or edema with engorgement of the lymph spaces and whiteness. Septic emboli are seen in the more severe infections and extensive suppurative conditions develop. Ulceration, obstruction, and gangrene play their parts here as in the previous stage. Repeated inflammatory involvement during this stage brings about permanent thickening of the appendix wall.

3. *Periappendicitis.*—Periappendicitis or inflammation "around" the appendix, means involvement of its peritoneal covering. This is the first step away from the appendix itself. In every case of gangrene or perforation the peritoneum dies or is ruptured at the point involved. This membranous outer layer may be the last to hold on, often protecting the abdominal cavity from infection through a thin film yet intact. Also, in cases which do not go on to perforation or gangrene, when the peritoneal coat is inflamed, contact with neighboring structures results in adhesions, Nature's offset to limit the inflammation. While such effort is worthy and frequently saves an immediate life, it may end in impairing the intestinal function or complicating the work of some other viscus. Thus the third pathological period terminates as the inflammation reaches and involves the last layer of the appendix.

4. *Para-Appendicitis.*—Para-appendicitis signifies inflammation "beyond" the appendix, extension of the process to parts entirely outside its borders. As soon as adhesions form by contact of the infected peritoneal covering of the appendix with other organs, the inflammation passes beyond the appendix. The terminating lesions will depend upon the structures invaded and the severity of the infective process. Perforation of the appendix will give rise to abscess formation, which will localize wherever the appendix happens to lie or in whatever direction gravity may point. The final resting place of the pus may be at a distance from the appendix, even from its perforated portion. In rare instances the appendix has perforated into some part of the intestinal lumen and so discharged itself without contamination of the peritoneum. Retroperitoneal and extraperitoneal formations of pus are met with. Without suppuration or perforation, adhesions which attach the appendix to near-by or distant organs vary from thin cobweb veils to dense cicatricial bands, from a small patch to an extensive inclusion of the intestines, gall-bladder and pelvic organs. Instead of circumscribed collections of pus, with or without gangrene of the appendix, there may be diffuse peritonitis, either serous or suppurative. The exudate varies from white patches and yellow streaks up to thin flakes of fibrin and grayish membranes. Further extension of this stage reaches the lymphatics and veins tributary to the portal system and brings on pylephlebitis. Collections high up eventuate in subdiaphragmatic abscess.

Such is the pathological course of appendicitis. It must be understood that at any stage the process may proceed to fulfillment without going through these distinct periods. The phenomena of the fourth stage may suddenly appear at any other preceding stage. Usually, however, the pathological program carries on regularly and valuable knowledge is possessed by observing it. The lesson to be learned from the classification is that in the early stage the inflammation is on the inner surface of the appendix, then in the middle layer and later on the outer surface up to the final stage, still confined to the appendix; but that in the fourth period the infection has gone beyond the appendix, invading other structures and tissue (Figs. 13 and 14).

It might be asked why do some inflammations of the appendix go on to destructive processes, while others develop slowly and conservatively? Why are some acute and others chronic? Why is appendicitis fulminant at times and mild at others? It has been held that these varying degrees of the pathological picture were due to the virulence of the bacteria and the resistance of the tissue cells. The type of organism is important, and the circulatory condition in the cells is none the less significant. Observations have proved that obstruction of the flow of lymph produces stoppage of the intercellular fluid, which forms a suitable culture-medium for aërobes; obstruction of the blood circulation gives rise to congestion, overloading the tissues with carbon dioxid—a favorable medium for the growth of the anaërobes. The latter cause liquefaction, gas formation and toxic reaction. The former phenomena furnish the less violent forms of appendicitis, with or without ulceration or leakage; the latter are associated with rapid breaking down of tissue, and widespread destruction and gangrene. Turner, whose views form the basis of this paragraph, contends that, since lesser degrees of obstruction will interfere with the lymph flow, and greater degrees with the blood flow, perhaps it is not so much the intrinsic virulence of the microörganism as the state of the culture-medium in which it develops. All kinds of bacteria may find their way into the tissue spaces but only some will multiply. All of these spaces are not equally stagnant and with every let-up of the obstruction the organisms may be carried down deeply until they reach a spot where active multiplication takes place. Gruner traced out a series of halting places and found that bacteria may lodge in the epithelium, in the interglandular tissue, in the deep sinuses of the mucosa, in the submucosa; or that they may enter the lymphatic plexuses of the appendix, thence being carried to far-lying regions, where they give rise to pylephlebitis, subphrenic abscess and other dangerous complications in the upper abdomen. On the other hand the inflammation may resolve and only scars be left to show a fibrous area, or develop a true obliteration of the lumen; or, with the scars, stagnant pools of lymph, providing a convenient nidus for fresh bacterial invasion and a recurrence of the pathological process.

Clinical Classification.—Pathological classification upon a clinical basis may be outlined as follows:

I. Acute appendicitis
    1. Catarrhal
    2. Interstitial

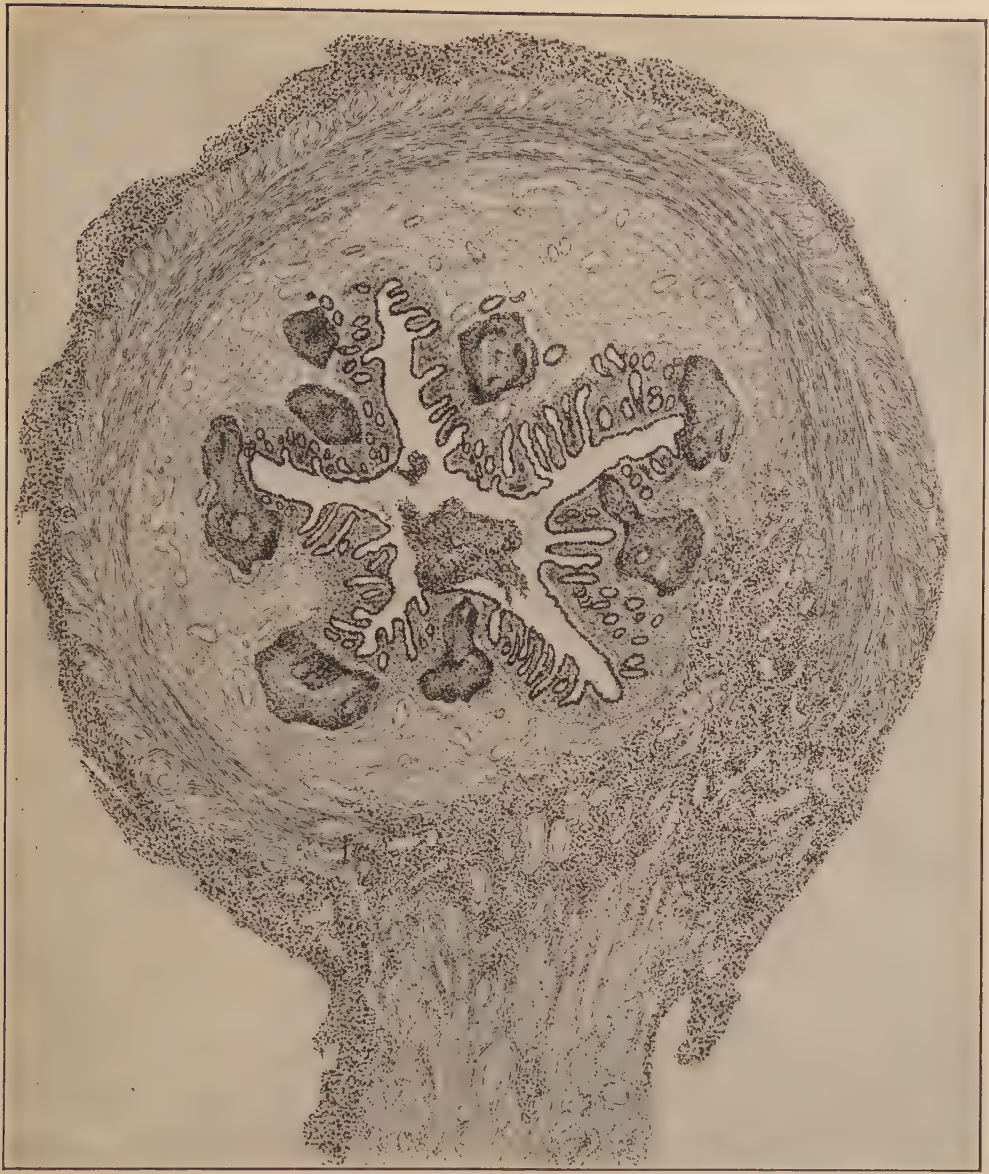

Fig. 13.—Acute Suppurative Appendix Removed Twelve Hours after First Symptoms.

Streptococcus found in exudate. Pus and fibrin covering the appendix. Dense infiltration of wall of appendix with pus. Pus exudate in lumen. (Contrast with Fig. 10, p. 25.) (After Delafield and Prudden.)

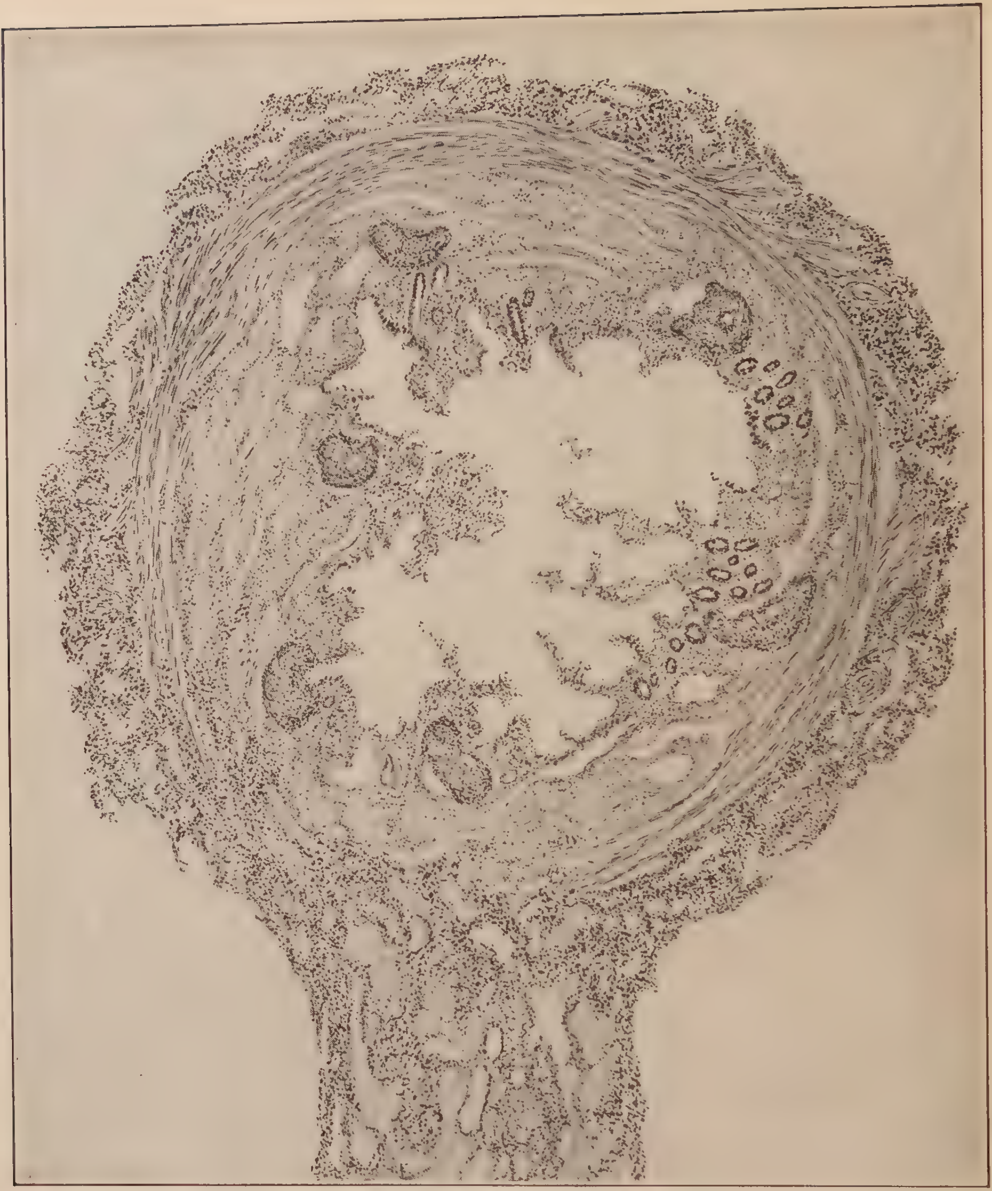

Fig. 14.—Acute Appendicitis, Suppurative; Advanced Stage.
From microscopic section of a case at the New York Hospital. (Contrast with Fig. 10, p. 25.)

    3. Ulcerative
        (*a*) Nonperforated
        (*b*) Perforated
    4. Suppurative
    5. Gangrenous
- II. Chronic appendicitis
    1. Catarrhal
    2. Interstitial
    3. Obliterating.

These are the usual forms found at operation in the different stages of the disease and they correspond closely with the changes just described. It must be clearly understood, however, that the divisions into stages, either clinical or pathological, are not absolute or uniform, that they may shade into each other, and that their schedule is indefinite.

Most important of all in considering endo-appendicitis, one should not be misled by the word *catarrhal*. It has been used to imply a mild form of the disease, so that, when an attack has been referred to as "catarrhal appendicitis," the inference was drawn that no danger was present and no infection existed. This is a precarious attitude. We know that every inflammatory process in mucous membrane begins with cloudy swelling of epithelium and "catarrh," followed by either resolution and adhesion or by suppuration and gangrene, depending on the virulence of organisms and the resistance of tissue cells. It is also a fact that in all such processes infection is the original cause, and its presence is to be assumed no matter how few or slight the pathological changes may be. In a first attack little, if any, evidence may be seen to account for the infection; but even in such a case the process can advance to the dangerous stage after a halt, and following repeated attacks of the same nature marked lesions appear (Fig. 15). So rare are the exceptions that it might be put down as a rule, once appendicitis always appendicitis, until the crippled structure is removed.

The interstitial type, parietal appendicitis, is represented in the acute form by a process which is arrested short of ulceration with its further consequences; and in the chronic form it presents the characteristic picture, thickening of the appendix wall at the expense of the lumen and the increased deposit of fibrous tissue and fat. Even in many of the advanced acute processes, associated with destructive lesions, interstitial changes are seen, having persisted through multiple attacks before the wall yielded at certain spots.

In the *ulcerative* variety is seen a progressive degree of endo-appendicitis when it is nonperforative, and a beginning periappendicitis the moment perforation takes place. It is possible to have a ruptured appendix without ulceration, but for the most part the ulceration naturally precedes the perforation, and this presupposes either a rapid erosion from very severe infection, or a gradual wearing through by mild but long-continued inflammation. What may happen after perforation is contingent upon the character of the appendical contents, and the reaction of the peritoneum and adjacent organs —leading to para-appendicitis.

Suppurative and *gangrenous* appendicitis attests the victory of the invading bacteria over the body cells and leukocytes. In the fulminating forms, it is a rapid and decisive rout; in the more prolonged processes, the yielding is more gradual, but none the less certain. When suppuration occurs the pus may be entirely within the lumen, free or encysted, and in addition may infiltrate the appendical wall with or without perforation. Gangrene ensues upon a block of the blood-vessels, causing death of the appendix in whole or in part—the high-water mark of appendicular infection.

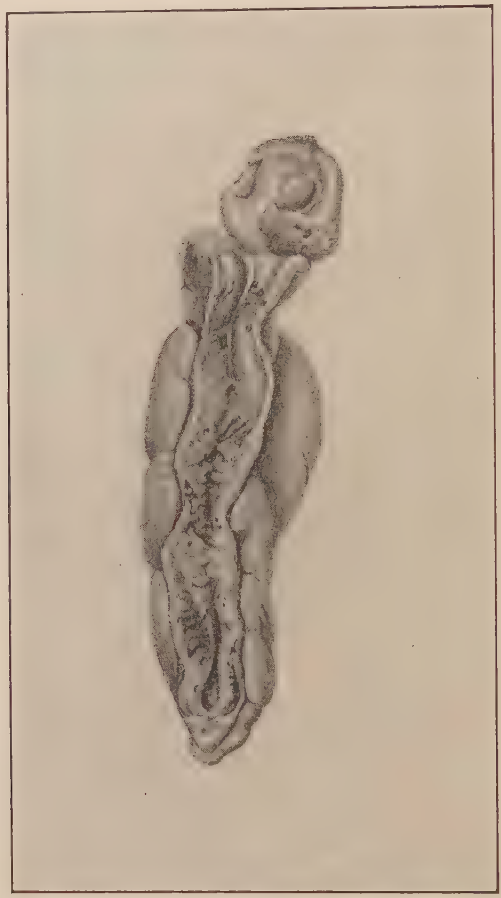

FIG. 15.—PETECHIAL HEMORRHAGIC AREAS ON MUCOSA OF APPENDIX, RESULTING FROM REPEATED MILD ATTACKS.

Chronic Appendicitis.—In chronic appendicitis as seen clinically, the gross pathological changes in the appendix fall under four ordinary types: increased vascularity, shown by congested blood-vessels; partial or complete obliteration with or without a bulbous tip; strictured and dilated portions of the lumen, possibly holding fecaliths; hard, enlarged lymph glands at the ileocolic angle.

An interesting development of the chronic forms is the name suggested first by Nicholas Senn in 1894—the so-called appendicitis obliterans. Catarrhal inflammation of long standing invariably produces interstitial involvement, causing the appendix to become firm and stiff and noncollapsible, with thickened walls. Its interior shows narrowing and stricture at certain areas, later resulting in partial or complete obliteration. This is probably due to gluing together of ulcerated spots, and healing across the lumen (Figs. 16 and 17). When this process occurs at scattered points, compartments are closed off containing at times fecal collections (Fig. 18). If it continues throughout the entire mucous membrane, complete obliteration occurs, and the appendix resolves into a fibrous cord without a canal. Before complete obstruction is effected, dilatation of the walls of the remaining lumen may

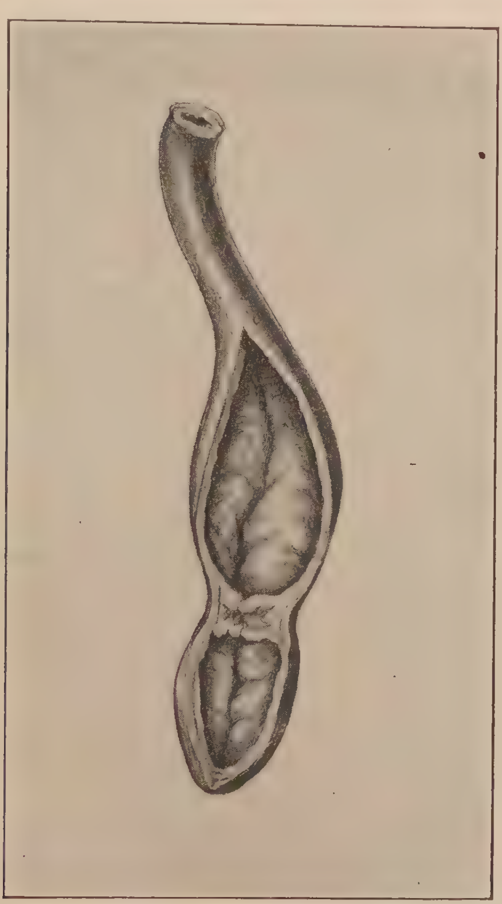

Fig. 16.—Stricture of Lumen of the Appendix, Near Tip.

occur, enclosing mucus or pus, and resulting in the formation of a retention cyst, empyema or a hydrops provided the cecal orifice is sealed. Obliteration most often begins in the tip of the appendix, its distal end, and progresses upward. It is rare to find an absolutely complete closure of the canal, for in most instances there is an area of unaffected mucous membrane, leaving a small open area near the base of the appendix (Fig. 19). Better blood supply at that extremity may account for the failure to fuse. Exceptionally the obliteration may extend to the cecal wall and the appendix may amputate itself by constriction.

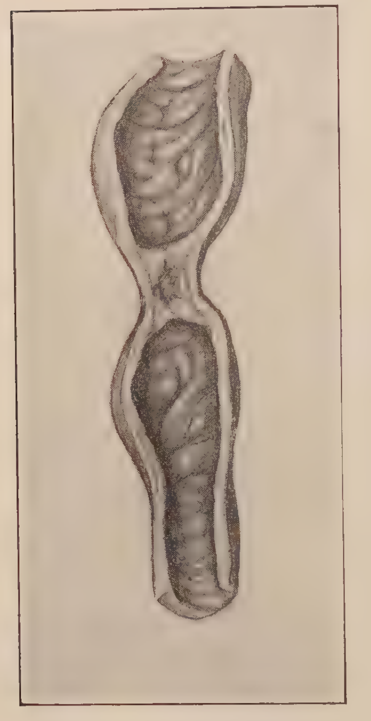

Fig. 17.—Stricture of Lumen of the Appednix, Nearer Base

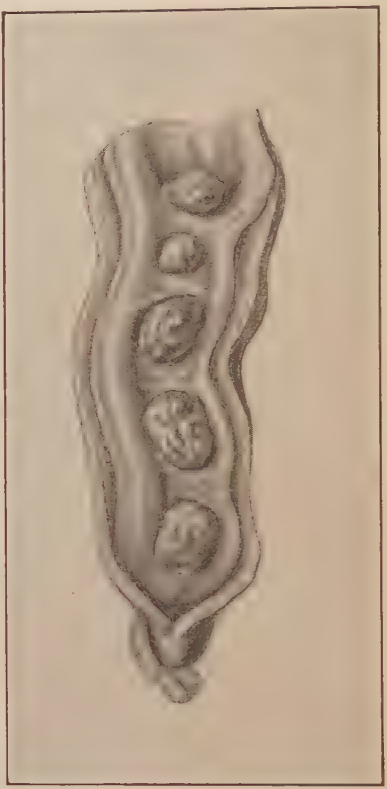

Fig. 18.—Appendix "Rosary"; Fecal Concretions Shut Off in Strictured Compartments.

"Pathologically," in the words of Watkins, "the chronic appendix is an end result and not an active process." He explains that should the inflammation affect one segment of the appendix more than another, the final healing fibrosis will result in strictures and an irregular lumen. Distal to such strictures, or between two of them, there will be sacculations in which the fecal contents may be trapped until they harden and concretions form, acting as ball valves to keep the appendix from emptying properly. The trapped contents invite the transformation of intestinal bacteria into pathogenic forms, or permit development of a few incidental already virulent bacteria into sufficient number to produce local or metastatic infection. The peritoneal exudate, when organized, may adhere the appendix to some neighboring structure, with varying effects upon the appendix itself or the organ to which it is adherent.

Some anatomists and a few surgeons have affirmed their belief in the existence of a physiological atrophy of the appendix in old age or after middle life, accompanied by obliteration of its cavity. Piersol said that "much more conclusive evidence is needed to establish" the truth of this statement and notes that Fawcett and Blatchford found the appendix pervious in 196 cases out of 221 and 91 of the pervious ones were from those over fifty years of age. He also refers to the studies of Ribbert, the first to make an extensive report on this question, who found obliteration in greater or less degree in 25 per cent of four hundred specimens—under twenty years in 32 per cent, after fifty years in 50 per cent, in the first five years, none; of the total, obliteration was complete in only 3.5 per cent, while in 50 per cent it involved but one-half of the tube. That atrophy of the appendix with an obliterative process comes on in patients after middle life is hardly to be denied. Whether this is a physiological or a pathological course it is difficult to say. It has been referred to as involution of the appendix and regarded as a distinct clinical entity. Its morbid anatomy resembles that of a chronic interstitial appendicitis, but undoubtedly this retrograde process occurs in many appendices which show no inflammatory affection. Admission of an involutionary reaction would tend to support the view which holds the appendix to be a vestigial organ, going back to its origin as the years advance. Upon the nature of this involution opinions are very much divided. On the one hand there is authority for considering it a natural affair; on the other hand some cannot agree that the process is physiological, since they have found it at all periods of life and fail to observe any increase in its tendency during old age; still others firmly assert that obliteration of the appendix comes always from inflammatory lesions. Radiologists of experience have stated that normal obliteration may begin as early as thirty years of age, and that Roentgen-ray studies in patients beyond that period are of little value in determining the contour of the appendix, unless allowance be made for this factor. In the midst of these varying views, it might be safe to con-

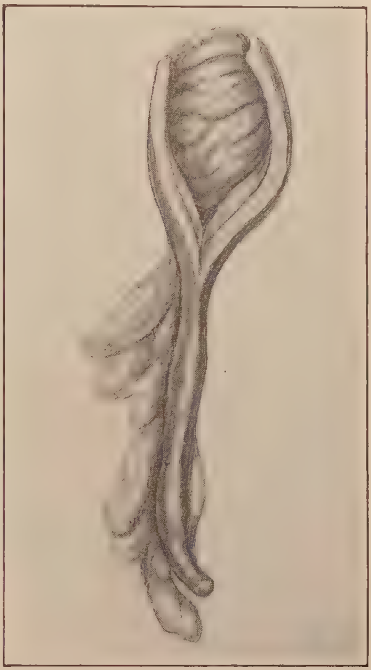

FIG. 19.—OBLITERATION OF THE APPENDIX, COMPLETE EXCEPT FOR AN EXPANDED AREA NEAR THE BASE.

clude that obliteration of the appendix may result from a chronic pathological process, or from a physiological atrophy. Whether any clinical differences between these two types are distinguishable is difficult to determine.

Robert T. Morris describes normal involution as follows: "Pathologically the change consists at first in a replacement of the lymphoid and mucous layers of the appendix with connective tissue, and this eventually includes the muscularis and all tissues excepting the peritoneum in many cases. Nerve filaments seem to persist in the connective tissue for a longer time than any of the other normal structures, and microscopic section of an involution appendix will often show an aggregation of new cells about the nerve-filaments. . . ." It is thought that an appendix undergoing involution is less apt to be the subject of real infective appendicitis. Morris compared the irritation of the nerve filaments in the contracting connective tissues of the appendix to a similar irritation of nerve filaments in the contracting scar of the stump of an amputated arm. This is confirmed by a very recent paper by Warren who noted in a study of 6,797 appendices, one, at least, which showed "a piling up of nerve and connective tissue in the scar of a healed appendicitis comparable to an amputation neuroma."

A summary of the different forms of appendicitis may be arranged thus, after Gruner:

TYPE	INITIAL FACTOR	BIOLOGICAL AGENT	HISTOLOGIC EFFECT	SITE OF LESION IN TISSUE	CLINICAL NAMES
Mild cases	Mild obstruction; deficient mucus	Toxins only; bacteria do not penetrate far, if at all	Irritant especially to cell growth	1. Follicle 2. Intergland-ular tissue 3. Submucosa 4. Lymph-channels	Appendicular colic; follicular appendicitis; simple appendicitis; later, scars
Moderately severe cases	More severe obstruction, *e.g.* fecal plug	Toxins and bacteria	Same	1–4. As above 5. Blood-vessels	Hemorrhagic appendicitis; later, chronic appendicitis; later obliterative appendicitis; scars
Severe cases	Complete obstruction	Bacterial invasion: Streptococci, pneumococci, B. coli	Destruction as well as irritation; ulceration, abscess	Mucosa *en masse*	Lacunar appendicitis; ulcerative appendicitis; suppurative appendicitis; periappendicitis
Very severe cases	Complete obstruction	Same as above especially anaërobes	Gangrene; perforation	All coats	Gangrenous appendicitis; perforative appendicitis

SPECIAL PATHOLOGY

Fat Reactions.—Special pathological research in appendicitis has been followed by a few observers. One of the interesting questions has been the fat reactions in the appendix. Several years ago Williams took up the study of abnormal fat assimilation in certain intestinal diseases. He thought that fat compounds were secreted by the intestinal glands and that they might obstruct the gland tubules, causing them to be more readily infected by bacteria. In the appendix this theory was applied by citing the concretions as not being fecal, but composed of insoluble soaps and fats. Kolodny studied the diseased appendix with special reference to the pathological accumulation of fat in the wall and examined about four hundred specimens surgically removed during a period of three years. In his opinion the deposits of fat in pathological appendices are constantly found, consisting of well developed masses of typical fatty tissue. They were present in all of his cases. In many specimens these fat deposits were so large that they formed a separate, distinct layer, which he suggests should be called the "stratum adiposum," of the submucosa. There appears to be a constant relationship between the degree of the pathological changes in the wall and the amounts of fat in it; the more chronic the process is the larger is the amount of fat in the submucosa. It is possible to establish the diagnosis on this single feature. The accumulations of fat do not depend upon the age of the patient, nor on his state of nutrition. A normal appendix, removed at autopsy from a body with a 1½ inch subcutaneous fat layer of the abdominal wall, did not contain a trace of fat in the submucosa, while a pathologic appendix removed at autopsy from a greatly emaciated body showed a distinct adipose layer in the submucosa. In the distribution of the fat tissue along the appendix, the largest amount is deposited in the distal part and less in the proximal. This is evident: the inflammatory process is more frequent and severe in the distal portion of the appendix. The accumulations of fat do not disappear from the submucosa even when the inflammation temporarily subsides and the involvent mucosa is regenerated.

Investigations of Dudgeon and Mitchner also were particularly concerned with the presence of fats in the appendix, finding them in the lumen, the walls, the ganglion cells and abundantly in the lymphoid tissues and the lymph glands. These observations caused the writers to believe that fats are absorbed from the lumen of the appendix—a view exactly opposite to that of Williams.

Whether the fats are secreted by the mucous glands of the appendix, as claimed by Williams, or are absorbed from the canal, according to Dudgeon and Mitchiner, it seems reasonable to conclude from the findings of Kolodny that the fats are closely associated with pathological changes in the appendix. Their presence would demonstrate altered physiology either in the direction of failure of absorption or excessive secretion.

The Nature of Fecal Accumulations.—This brings up the question of the origin of fecal concretions. Their relation to the etiology of appendicitis has already been discussed. Something of their formation and composition may be considered. Fecal matter caught in the appendix, at first liquid, then as a soft mold, and remaining too long, becomes inspissated from absorption of its water and finally comes to be a hard mass. Mucus is excreted in excess from the epithelial lining, catarrh supervenes, edema results, dilatation occurs; the fecal mass grows larger by accretion like a snowball, and harder and dryer by loss of liquid until by virtue of its size and lack of tone in the appendix walls, it is incapable of extrusion. Thus a fecalith is formed, usually existing singly; but there may be two or more. When multiple they can be felt through the unopened appendix, like beads on a rosary. Their size is variable, very large ones being rare. The largest are often found outside the appendix free in the abdominal cavity with exudate or pus, having escaped through a perforation. In shape concretions are generally oval, occasionally very long, seldom pointed; in color they are most often brownish yellow, at times whitish or grey.

When cut through, these concretions are seen to have a central core of hardened feces surrounded by successive layers of varying consistence, becoming softer toward the periphery. In these definitely lamellated rings are deposited loose epithelium, dried mucus, pus cells and intestinal débris, piled up around the fecal center. The outer layer is rather intimately attached to the mucous membrane of the appendix and sometimes almost continuous with it. Different colors are sometimes seen. in the layers of the mass, probably on account of the changing character of the deposits. Chemically fecal concretions are composed of calcium salts (carbonates, sulphates and phosphates), magnesium phosphate, fats, vegetable matter, cholesterin, etc. Soaps are found when the fatty acids are acted upon freely by the alkaline salts. A dry concretion of long standing has a very slight musty odor, at times no odor at all; while a softer, more recent mass gives out a foul fecal smell. Vermooten discovered four calculi in an appendix. They were composed largely of calcium phosphate but contained small quantities of cholesterol, some silica and a trace of bile pigment.

Polarized Light Tests.—An observation by Gargano depends on the fact that the normal double refracting power of polarized light in contractile muscle fibers is a test of its vitality. In chronic inflammations this property is lost. The appendix may look sound and normal, but if its musculature does not exhibit double refraction, chronic inflammation may be assumed.

Floating Appendix.—"Floating appendix" is the term applied by Chapman to an appendix, which, as soon as the abdomen is opened, is seen to be free, erected, and of a vivid scarlet color, especially toward the tip. No sloughing is present, no adhesions, no plastic lymph; but clear, odorless fluid in the cavity and congestion of the surrounding peritoneum. Three cases are detailed in the report.

Cysts, Diverticula, Implantations.—Cystic accumulations in the appendix may take the form of mucocele, hydrops, empyema, or hematocele, according to the character of the retained material. Their origin has been referred to. They are the products of chronic inflammation, such as is seen in other tubular structures of the body, and they imply a closure of the canal in whole or in part. A shut-off area allows them to develop and their size depends upon the length of time they are permitted to grow. Cysts of the appendix are not very rare, certainly not so uncommon as to be classed with surgical curiosities. I have observed several, exhibiting each variety of contents. The bloody retention cysts are encountered, according to our experience, particularly in operations following a late period after a violent attack of which the patient had not been completely relieved. Now and then fresh clots are seen slightly adherent to the appendix walls. Hydrops is produced by absorption of solid parts of the cyst contents and retention of the clear watery fluid. Infection with bacteria brings about empyema or pyo-appendix. This may precede the hydrops.

Appendicular dropsy is discussed by Petrescu and Lazarescu. They compare it to hydrops of the biliary vesicle and found its contents similar to "white bile." The histological structure also is the same in both instances, the same coats in the walls of each structure, having a common embryonic origin and an identical pathogenesis and progress. Their specimen was that of a cystic dilatation the size of a prune in the middle portion of the appendix, containing 4 centimeters of sterile liquid.

Cystic elevations of the peritoneal surface of the appendix occasionally are met with. Some of those protrude through the appendical coats from the mucous lining and are, therefore, genuine mucoceles—rarely the cause of ileus, as reported in one case by Wegener; by far the largest number are superficial retention areas just under or within the serous layer,

Large cystic appendices are occasionally found. In a contribution to the study of the "giant appendix" Hamant and Mathieu were able to round up from the reports a group of cases, fifty-five discovered at autopsy and sixty-six at operation. The etiology may be a normal involution or obliteration, a general proliferative and ulcerative process, or specific infection such as typhoid, tuberculosis, and syphilis. Malignant changes in the appendix give rise to large appendical masses. Occasionally twists or compressions may be the cause. The size of the masses varies from that of an adult finger to that of an adult head. The contents are usually mucoid in character and the walls show changes due to distention and inflammation. The complications are infection, descent into a hernial sac, rupture of the cyst, and peritoneal pseudomyxoma. The authors add three cases of their own.

An instance of this type is recorded by Sanders, who believes his specimen the largest yet reported (Figs. 20, 21, 22). It weighed 450 grams and measured 37 centimeters in its greatest circumference and 25 centimeters at a right angle to this. The cyst was connected with the entire circumference of the appendix. It contained a grayish semitranslucent ropy material—a true mucous cyst. In the same article Sanders also reports another cyst of the same character, about one-third the size of the previous one.

The giant appendix (mucocele) reported by Trauba measured 4¼ inches (10.7 cm.) long and 4½ inches (11.5 cm.) in circumference. It was of a dull white appearance with a smooth surface.

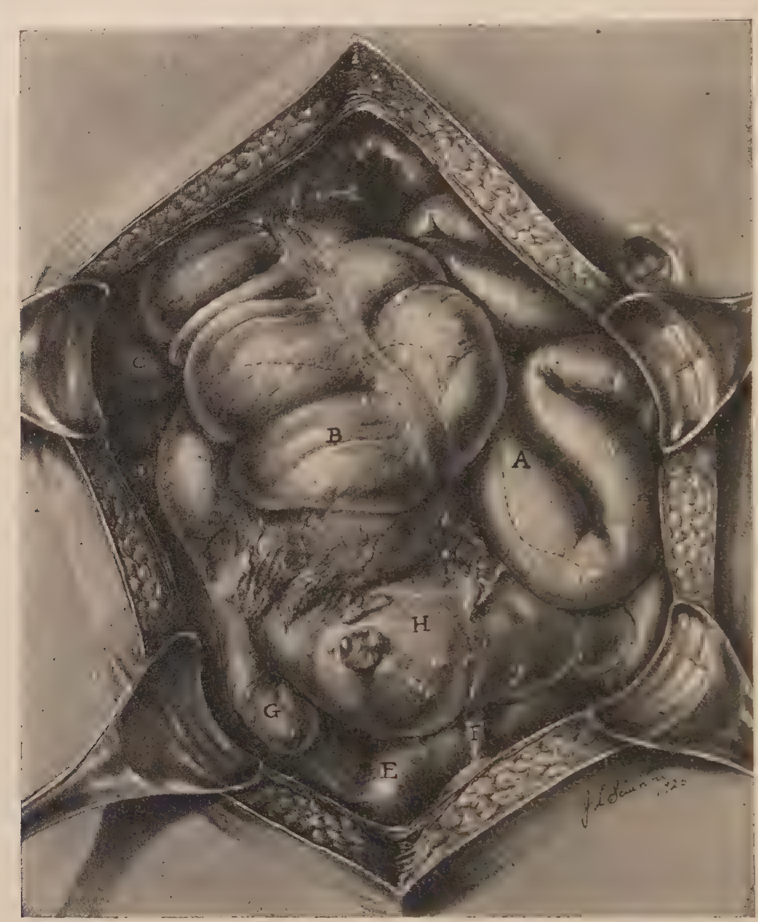

Fig. 20.—Mucous Cyst of the Appendix *in situ* Exposed through a Right Rectus Incision.

A, ileum; *B*, cecum; *C*, lower pole of right kidney; *D*, crest of ileum; *E*, rim of pelvis; *F*, right ureter; *G*, tip of appendix; *H*, cyst. (R. L. Sanders.)

A gigantic appendix containing a collection of colloidal granules (myxoglobulose, Hansemann) was found by Megevand at necropsy upon the body of a laboring man of sixty-seven years, found dead in his room. The appendix had the appearance of a sac, dilated its entire length and shaped like a crescent. It was 14 centimeters long: its circumference at the base was 9 centimeters, at the middle 12 centimeters and at the tip 6 centimeters. There was no sign of recent inflammation. The appendicular contents were a yellowish-white, thick substance, composed of rounded masses, small gelatinous balls, varying in size from a pinhead to a grain of rice. The walls of the appendix were very thin, in some places transparent where the mucosa was destroyed. The cecal orifice was obliterated. It is believed that this type of cystic appendix is related to pseudomyxoma of the peritoneum. While appendicular mucoceles of gelatinous content, not molded into shapes, are not very rare, Megevand has found but a very small number of cases in the literature, in which the content was composed of these small balls of colloidal appearance.

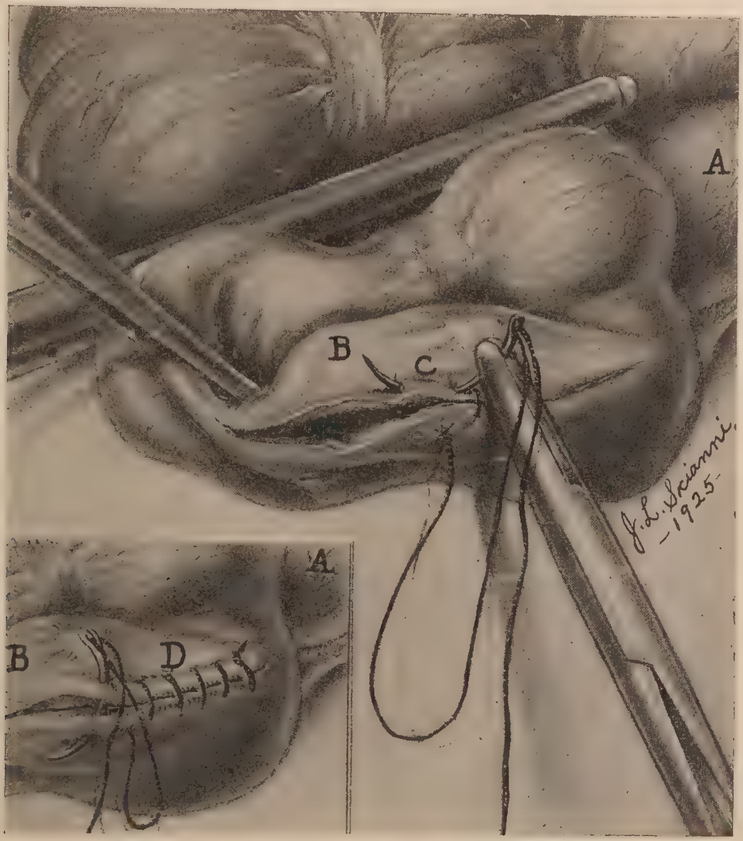

Fig. 21.—After Removal of Cyst.

A, ileum; *B*, cecum; *C*, closure of opening into cecum by double Connell suture; *D* (inset), further closure by an external over-and-over suture. (R. L. Sanders.)

Pseudomyxoma peritonei resulting from extension and transplantation by way of the appendix does not seem to be so tragically malignant as the same process coming from ovarian sources. And yet one must not presume on the constantly benign type of pseudomucinous cysts of the appendix. Their nature is uncertain, and their course treacherous; there is no positive way, either pathological or clinical, to determine whether this peculiar growth be simple or carcinomatous.

A distinct type of lesion, cystic appendicitis, is noted by Oudard in a case of his own. The appendix exhibited a stenosis with a chronic sclerotic process, evidences of old inflammation; in addition to this, there was a diverticulum at the base and four subserous cysts were found, entirely separate from the diverticulum, arising in vascular areas and lacking epithelial tissue. Oudard considers his specimen as differing from the ordinary types of mucocele and diverticular cysts, chiefly in the fact that while, in the majority of cases there is a communication between the cavities of the cysts and the appendix, in his case the cystic formations were completely independent of the diverticulum.

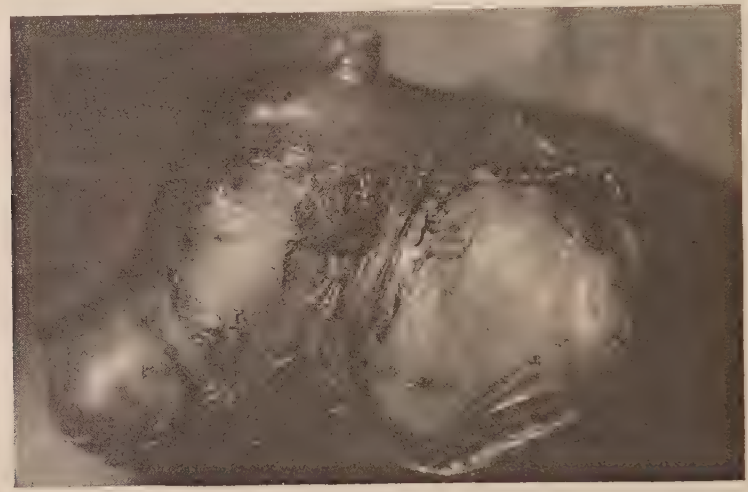

FIG. 22.—PHOTOGRAPH OF CYST OF APPENDIX AFTER REMOVAL. (R. L. Sanders.)

An echinococcus cyst of the appendix is reported by Brewer from Chefoo, China. "It was 8 centimeters long and 1.5 centimeters in diameter, with a smooth, white surface tightly distended, fluctuating, and possessing hydatid fremitus. When opened, a cyst cavity was revealed containing many secondary and tertiary cysts. This cavity extended from the tip to the narrowed base of the appendix, where the lumen was obliterated. A small, incompletely separated compartment at the tip suggested that the process may have started here in the wall of the appendix."

Diverticula of the appendix might well have deserved attention under the chapter on anatomical considerations, as developmental anomalies. But, since the consensus of opinion is against such origin and since they take on pathological and clinical importance, they are properly considered at this time. A true diverticulum is a pouch whose lumen is continuous with the cavity of a viscus; it is an offshoot or culdesac.

In the case of the appendix the diverticulum is sometimes as large as, or larger than, the original tube. Malone has presented a specimen of what he regards as a real congenital diverticulum of the appendix (Fig. 23), and he finds on record no case similar to it. His patient was a man of twenty-three years, operated upon eleven hours after the onset of an acute abdominal attack, a repetition of several attacks during the previous six years. The appendix was covered by exudate and the lumen contained purulent material; near its middle was a diverticulum about the same size as the appendix, with a somewhat larger lumen and corresponding layers in its walls showing similar inflammation to that of the appendix. Malone gives Stout credit for the statement that, though numerous instances have been reported in which there had occurred a protrusion of the mucosa and submucosa through a defect in the muscular coat of the appendix, all these cases were acquired and that a true congenital diverticulum of the appendix had never been reported.

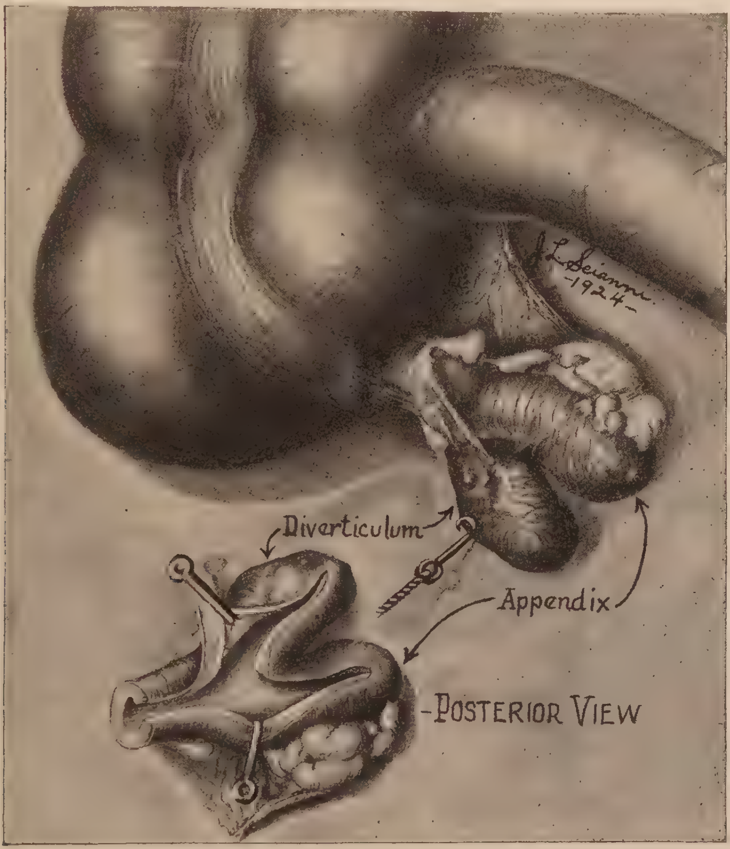

FIG. 23.—ACUTE SUPPURATIVE APPENDICITIS AND DIVERTICULUM. (Battle Malone.)

Bachlechner's case, which the author believed also to be "probably congenital in origin" was that of a boy of seventeen years of age, who, in prior good health, the day before admission was seized with severe, colicky pains in the right lower abdomen and continuous vomiting. All symptoms pointed to appendicitis. Immediate operation was performed. On opening the abdomen there escaped some turbid serous fluid from the peritoneum. On drawing forward the cecum, the appendix was found somewhat rigid, but not highly inflamed. From its proximal end there sprang a bluish-black cystic tumor, extending down into the lower abdomen. On enlarging the incision the tumor was fully exposed, measuring 12 centimeters in length, arising at the proximal end of the appendix. It was cystic and twisted at its origin 180°, involving a portion of the appendix and mesentery in the torsion. After releasing the torsion the mass was removed along with the appendix. Histologic examination showed that it was not a duplicature of the appendix, but a diverticulum.

The distinction between congenital and acquired diverticula is discussed by Gullotta. The congenital diverticula are characterized by walls made up of all the intestinal tunics, by their location in any part of the appendix, and by "their absolute clinical silence." The acquired diverticula have incomplete walls; the muscularis mucosæ is always lacking in them. The acquired form is more common. Two types are seen, the simple and the cystic. As to origin they may be inflammatory or noninflammatory, the first being largely due to intramural suppurations of the appendix and the second to appendicular hypertension and obliteration. He considers congenital diverticula to be less rare than other authors seem to believe, claiming that they are overlooked by surgeon and dissector, and on account of their normal histological structure and function they are not clinically observable and do not attract attention. Only four clinical cases were found in the literature by Gullotta: those of Hedinger (1904), Sissojeff (1911), Jacquemont (1912), and Stürm (1915). He adds another case, making a total of five in which the congenital type of the diverticulum cannot be doubted. Section of the specimen made across the lumen at different levels showed the relation of the appendix canal to that of the diverticulum (Fig. 24).

Endometrial Transplants.—A rather remarkable feature of appendical pathology is the implantation of cysts of endometrial origin in the wall of the appendix. Attention was brought to this unusual finding through routine microscopic examinations. Many of these epithelial proliferations first were diagnosed as cancers, until their benign nature was recognized. Outerbridge had four such cases, all in women, exhibiting marked chronic inflammatory changes in the appendix. The cystic cavities were in the deeper portions of the walls, lined by one layer of columnar epithelium and either empty or filled with blood and tissue débris. Their uterine source is evident; the endometrial tissue escapes by way of the fallopian tube to the ovary, first implanting itself there in the form of cysts (*cf.* chocolate cysts of Sampson), then invading other structures—the broad ligaments, the sigmoid flexure, and less frequently the cecum and the appendix. Sometimes the transition is direct from the tube to the intestine. Careful investigation will prove the implants to be more common than generally suspected. No less than eight cases are now on record. The importance of differentiating them from carcinoma must be kept in mind. They are not malignant.

Seelig's study of this newly discovered growth in the appendix which he calls "endometrial adenoma," brings to light the fact that the process is not uncommon. The case which he reports presented an appendix an inch long, constituting a mass the size of a pecan, which was at first thought to be carcinoma. Even under the microscope this diagnosis was confirmed until further thought suggested endometrial implantation. Sections showed distinct acini, and a definite arrangement of typical utricular glands (Figs. 25, 26). According to Seelig, "the characteristic features of the disease are: (1) its exclusive occurrence in women; (2) the age incidence of from the thirtieth year to the age of the menopause; (3) the accompanying lesions of the genital tract, rectum, sigmoid and higher intestinal tract; (4) the history of sterility, acquired painful menstruation, symptoms of chronic intestinal obstruction and acute exacerbation of pain at the menstrual periods, and (5) the tendency to spontaneous regression after the menopause."

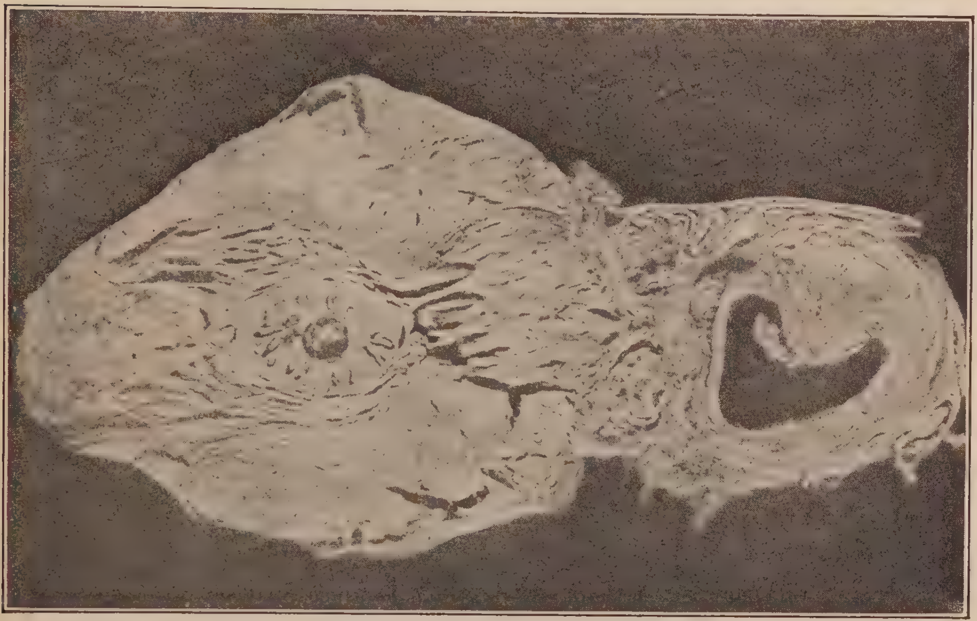

Fig. 24.—Cavity of Diverticulum Shown at Right; Appendicular Lumen, Perfectly Circular, Containing Amorphous Detritus and Epithelial Cells, with Cubic Epithelium of Mucosa Intact, Easily Seen at Left. (Gullotta.)

New Growths, Tuberculosis, Actinomycosis, Carcinoma.—With the exceptions of those just described, other *benign lesions* and neoplasms are exceedingly rare.

Polypi.—An "intra-appendical polyp" was observed by Vanden Berg and

German. It was a simple polypus, the size of a hazelnut, situated near the base, covered by a single layer of mucous membrane and discovered in the course of an operation for acute appendicitis, of which it was very likely the cause by its valvelike action in blocking the cecal opening. The authors cite three cases from the literature—Vogel (1911), Flamm (1912), and Sitkowski (1913)—as the only ones reported up to 1925. Kelly's book (1905) contains a record of four cases.

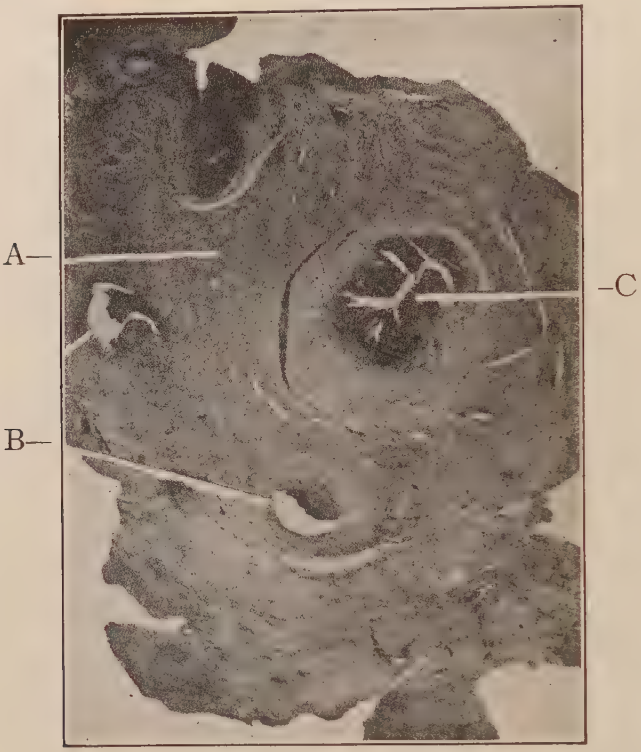

FIG. 25.—LOW-POWER PICTURE OF SECTION TRANSVERSELY THROUGH APPENDIX SHOWING LUMEN, WALL OF APPENDIX, AND ENDOMETRIAL TISSUE.

Note the marked hypertrophy of muscle coats (myoplastic reaction). *A*, wall of appendix; *B*, endometrial tissue; *C*, lumen of appendix. (Seelig.)

A case of "polyposis of the appendix vermiformis with intussusception of the appendix" was reported by Horn three months after the above paper appeared. The proximal half of the appendix presented a uniformly polypoid degeneration, nodular but of soft consistence, involving the walls and the serous coat. The growth was a papillary adenoma. Horn mentions three cases similar to his own and one of a simple polyp of the mucous membrane.

I have seen two appendices showing a polyp growing from the mucous membrane and one with a small papilloma in the wall presenting on its serous surface.

Lymphadenoma, fibroma, myoma and myxoma have been found in the appendix.

Tuberculosis.—Tuberculosis of the appendix generally is secondary to the disease occurring in some other part of the abdominal cavity. The original focus is most often the cecum in either sex and the fallopian tubes in the female.

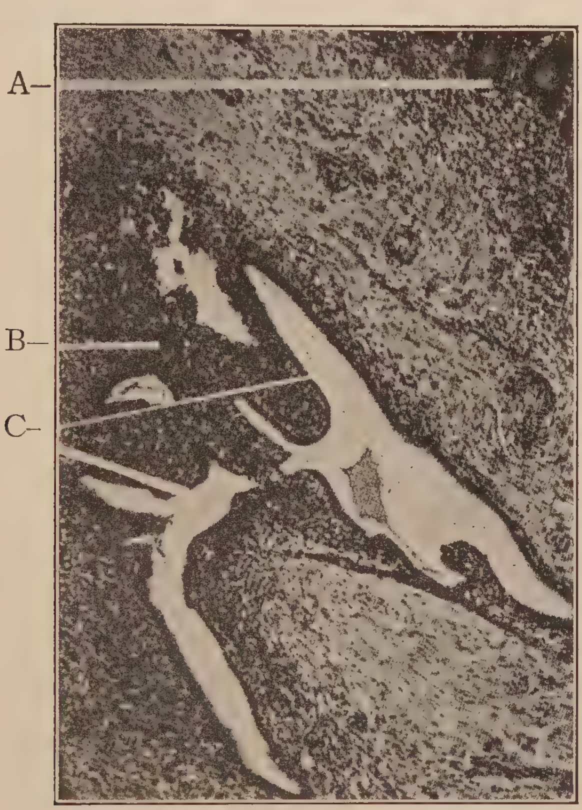

FIG. 26.—HIGH POWER. WELL-DEVELOPED ENDOMETRIAL TISSUE JUST BENEATH LUMEN OF APPENDIX.

Note the ciliated epithelium lining the glands. *A*, lumen of appendix; *B*, endometrium of stroma; *C*, endometrium of gland. (Seelig.)

Three forms are recognized: the hyperplastic, the ulcerative and the miliary. The first is the most favorable type, because like all fibrotic changes, it shows greater tissue resistance. The ulcerative form begins on the mucous membrane and is often unsuspected in its early stage. The miliary type soon invades the serous and muscular layers and the cecum if, indeed, it does not originate in the cecum, and is associated with a systemic or a general abdominal tuberculosis. About one-half the cases will show a tuberculous lesion of the serous coat of the appendix only; and in the same number will the disease be found in the mucosa and submucosa. Routine microscopic examination of all appendices removed would bring to light many additional tuberculous cases.

Medical literature singularly is quite barren of reports upon appendical tuberculosis. Tennant and Haggart believe this is due to the actual rarity of the disease except as a terminal process and to the difficulty of its recognition in the early stages both by the surgeon and by the pathologist. Later when a mass forms and fecal fistula develops the etiology is apparent. These writers consider it more commonly a primary infection than is generally accepted, believing that it "develops probably from contaminated fecal content at the point where intestinal stasis is most marked." This is not generally accepted. Freeman who took part in the above discussion, does not believe that tuberculous appendicitis results from the intestinal canal, otherwise patients with pulmonary tuberculosis would show a large percentage of tuberculous appendices—which is not the case; but, by analogy with the entrance of tuberculosis into other parts of the body, he believes that it invades the appendix, also, through the lymphatics or the blood-vessels. Direct extension of the tuberculous process is observed in the presence of peritonitis or salpingitis of the same origin. Paradoxically Tennant and Haggart state that it is the ordinary acute, pyogenic appendix which is most frequently found in the tuberculous individual.

Once involved the appendix may break down and an abscess may form, especially if the cecal wall is invaded. In a diffuse tuberculous peritonitis the appendix is affected through its mesentery or its outer coat—studded with tubercles, thickened, nodular, edematous. Primary tuberculosis of the appendix, with no demonstrable tuberculous lesion elsewhere in the body, is a very rare condition. One such occurred in my practice: a woman, fifty years of age, weighing 210 pounds, operated upon in 1909 under a diagnosis of appendicitis. The appendix was 2 inches in length and embedded in fat; near its distal extremity were three elevated whitish areas, precisely like "blisters," oblong in shape, about the size of an ordinary bean and containing a thin fluid. Sections demonstrated tubercles. The patient lived fifteen years, dying of an intercurrent disease.

The cecum is sometimes the seat of abdominal *actinomycosis.* A few cases, however, have been recorded in which the disease primarily involved the appendix. The infection occurs either directly through the intestinal tract, indirectly from the chest cavity, or distantly by metastasis. On account of the association of this rare disease with other types producing pus and fistulæ it may be overlooked and may appear to be less common than it is thought to be. The peculiar morbid changes are indurated connective tissue, riddled with suppurative foci, and gray nodules containing the ray fungus. An early case of actinomycosis of the appendix is recently reported by Baron: A cowman, aged fifty, was seized two days previously with abdominal pain, tenderness and rigidity, with vomiting. At operation was found an inflamed appendix, containing a whitish concretion and brownish pus was removed from the lower part of the cavity. This pus showed streptothrix threads, yielding a few colonies of colon bacillus on smears and the concretion was infiltrated with actinomyces. The wound was slow in healing, but upon giving large doses of potassium iodid and irrigating with tincture of iodin solution, rapid improvement took place.

Carcinoma.—Systematic pathological investigations of all appendices removed at operation have revealed a larger number of cancers of the appendix than were conceived of many years ago. A prominent observer found carcinoma in one out of every 225 appendices examined. Studies of the condition by several pathologists bring out some striking facts: that the average age of occurrence is about thirty years; that the growths are clinically benign, though histologically malignant; that they practically always form near the tip of the appendix; that they are of small size and show no tendency to encroach upon the peritoneal covering. Long ago McKenty pointed out that up to his time there was no authentic case of metastatic growth following a carcinoma of the appendix in which the spread of the disease from the cecum to the appendix could be excluded.

Aschoff holds that this neoplasm is not a carcinoma, but a nevus-like growth occurring in a mucous membrane. "Carcinoid" has been proposed as a suitable name. Others look upon these tumors as inflammatory; still others called them endotheliomata; some question even their histological malignancy. In a late review Warren found twenty-six carcinoids (nineteen in women) out of 6,797 appendices examined, and says that they may be of inflammatory origin. From the same series he reports two cases of malignant adenoma and two of colloid carcinoma, all primary in the appendix. Boyd is authority for the statements that the typical carcinoma of the appendix has never produced metastases in any recorded case and never caused the death of the patient. He describes the pathological appearance as a thickening of the appendix resulting from chronic inflammation and no other abnormality until sectioned, when there is revealed a yellowish white ring encircling the appendix. This phase of appendical pathology assumes a certain degree of interest in connection with appendicitis, owing to the fact that ordinarily growths of this nature would not be discovered during the operation for removal of the appendix, unless critical attention were given to the question.

Gerlach has emphasized the difference between true carcinoma and the so-called "carcinoids" of the appendix. He regards carcinoma as being very rare, always occurring at the cancer age and showing the characteristics of the cancer of any part of the intestine. The latter he prefers to call choristomata [defined by Stedman as "neoplasms due to hyperplasia of an aberrant anlage"], finds them much more common, benign in their behavior, always in young persons, never beyond a small size and not associated with the early stages of a real carcinoma.

A study of sixty-four cases by A. S. Jackson convinced him that the prognosis following early removal of a carcinomatous appendix is more favorable than that for malignant disease in any other part of the gastro-intestinal tract, and that there is a definite relation between chronic appendicitis and cancer of the appendix.

Meyer's views coincide with the above as well as with those of others. He refers to the various designations of these "carcinoid" tumors: mucous nevi, lymphendotheliomata, neurocystomata, lymphangeitis hyperplastica. His assumption is that "carcinoid develops from an embryonic rest at the time of the formation of the cell masses of the glands of Lieberkühn."

Agreeing with this origin of "carcinoids," Forbus declared them to be tumors of the chromaffin system, of the argentaffin type, on account of the peculiar ability of their granules to reduce an ammoniacal solution of silver.

Von Rehren calls attention to the fact that Kultschitzky has described the cells in the basal portion of Lieberkühn's follicles, cells with basophilar nucleation, the granula of which is affinitive to both silver and chromium. Work in recent years has been directed to the question whether these cells are the cells of origin in carcinoid of the intestinal tract, and Masson was the first to demonstrate that carcinoid of the appendix was due to proliferation of these cells. It is of interest to know, in examining a case of malignant carcinoid of the appendix, whether this silver affinity of the granula is also retained in other atypical growths and in the metastasis and if this finding could be utilized in the differential diagnosis of tumors of the abdomen. Von Rehren was able to demonstrate this point in the autopsy of two cases anatomically identical. Both showed diffuse distribution of nodules over the peritoneum with a tumor situated in the wall of the lower third of the appendix. The macroscopic appearance in both suggested malignant tumors; in one the diagnosis was confirmed, whilst the other proved to be biologically a small ovarian carcinoid with extensive metastases in the peritoneum and appendix.

Genuine primary carcinoma of the appendix is described by Shaw as a small round yellowish growth at the distal end of the organ, which on microscopic examination is found to contain colonies of rounded cells lying in well-marked alveoli and often invading the alveolar wall. There are also columnar cells arranged in a ringlike manner.

Wilkie reports three rather remarkable cases of carcinoma of the appendix, all operated upon for acute symptoms, and each showing obstruction of the lumen and a diverticulum.

The conclusions drawn by Van Alstine from experience with two cases and a recent review of the literature lead him to note the occurrence of primary carcinoma in at least 0.5 per cent of removed appendices; to distinguish the two types, basal-celled and columnar—the first more common, and the latter more malignant; to regard them all as potentially prone to malignancy and consequently to advise removal of "the appendix regardless of appearance or of symptoms whenever opening the abdomen in its neighborhood."

Sarcoma.—Sarcoma of the appendix is exceedingly rare. In presenting a report of a lymphosarcoma of the appendix with a nonrotated cecum

Friend was able to find but nineteen cases, all told, of primary appendical sarcoma in the entire medical literature of the world. The most common type is the small round-cell variety.

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CHAPTER VI

SYMPTOMATOLOGY

Clinically there are two main varieties of appendicitis, the acute and the chronic, both having to do with the character and duration of the phenomena presented. Two other forms secondary might be recognized: the subacute, subsiding after an attack, but not yet well; and the relapsing or recurrent variety, types constituting exacerbations of chronic appendicitis.

The symptoms will be described, first, under the heading of acute appendicitis; and second, of chronic appendicitis, after which reference will be made to the atypical forms.

The so-called "signs" of appendicitis will be discussed in the chapter on Diagnosis.

ACUTE APPENDICITIS

The symptoms of acute appendicitis, in order of frequency and importance, are pain, vomiting, tenderness, rigidity, fever and leukocytosis. Each one of these will need qualification, in order that they may be interpreted intelligently. It will be noticed that both subjective and objective signs are included, the general and the local manifestations, since they are equally concerned in the clinical picture.

Pain.—This is the earliest, the most constant and the most essential symptom. Ninety-nine times out of a hundred it is general at first, beginning either at the epigastrium, in the umbilical region, or rarely in the left abdomen. Its onset is sudden and in those who are enjoying their usual good health. The patient generally thinks he has "the colic," such is the character and location of the pain. After a period of time varying from six to twenty-four hours the pain localizes in the right lower quadrant of the abdomen and, often without asking questions, the sufferer will describe this gradual transit of the pain from the midabdomen toward the "right side." Here the pain usually settles and persists until checked by the normal ebb of the sudden attack or by incidence of tragic pathology.

Any pain originating over the appendix may be looked upon as not suspicious of appendicitis until the reverse can be proven; while a pain beginning "all over" the abdomen should be regarded as a sign of probable appendicitis even before it locates in the right lower abdomen.

As the pain continues it may become a steady dull ache, assume an intermittent quality, and in very mild attacks subside in an hour or two. It is increased by change of position, jarring of the body, the upright position and pressure by the hand. Turning on the left side is especially apt to produce accession of the suffering, because by this maneuver the right colon drops inward, causing great displacement of the appendix and traction at its attachments. The degree of pain differs noticeably. It bears no direct relation to the pathological changes in the appendix; but, as a rule, the most intense suffering is seen in the fulminating types, showing rapid development of the morbid process. Many times however, complete sloughing of the appendix is to be found when the initial pain was light and short-lived. The temperament of the patient will have much to do with the subjective manifestation of the pain. Some will complain bitterly and react excitedly in the presence of slight suffering, while others will endure with complacence the most violent agony. It is useful to take account of this personal equation; for one might become alarmed unduly and thrown off the track by the former individual or fail to grasp the situation in the latter. There is no more delicate matter in the observation of appendical patients than the elucidation of the incipient pain and of its relation to the other symptoms.

More significant than the degree of pain is its duration. There is no rule to follow as a guide. In a typical mild attack the pain begins to subside after twenty-four hours and is practically gone in forty-eight hours, unless some untoward and unusual phenomenon turns up. The tendency here is to recovery from the acute attack. Often the pain steadily increases, denoting more and more distention of the appendix, with edema and infiltration of the walls, until either it is removed or ruptures. In the short sharp type of pain, the appendix may be filled with a fecal concretion, inciting a so-called "appendicular colic" and being relieved by discharge of the contents. In the presence of continuing pain it is safe to suppose the appendix is intact, no matter what the duration of the pain. When the pain subsides slowly after a rather short time and with no cessation of other symptoms, gangrene may be suspected; when the duration is longer and the symptoms are declining, recovery from the attack may be predicted. If the pain ceases suddenly, especially following a marked increase in severity, perforation of the appendix is probable. This is the most serious disaster that can befall the patient and it may be averted by a proper understanding of the significance of pain. Pain is a pointing of nature, a reliable index that something is wrong. If we adjudge it correctly and follow its lead, a safe issue most likely will follow. Above all it must be remembered that in acute appendicitis the abrupt relief from pain does not mean necessarily that the patient is better, but very often that he is much worse. A false sense of security here has caused countless fatalities.

After the departure of the original pain, when gangrene or perforation has occurred, a secondary pain appears, due to extension of the infection beyond the confines of the appendix. This is a peritoneal pain. It may be due to an involvement of the serous coat of the appendix—to a peritonitis affecting the parietal area or the posterior portion—or to the formation of an abscess in the pelvis or the iliac fossa. The location of the pain would then depend upon the position of the appendix and the direction of the inflammatory process. In these circumstances pain may be found in the right loin, or liver region, over the bladder, down the thigh and to the knee, in the right testis or the left iliac region.

Vorschütz emphasizes the fact that pain in the stomach appears before the pain in the right lower abdomen and is a forerunner of the disease. It has been often overlooked in the diagnosis and attributed to simple gastric catarrh. It has its origin in the solar ganglion. Owing to the peculiar distribution of the nerve supply coming from the ganglion, the epigastric pain gradually disappears and as the pain on pressure is felt in the appendix region the diagnosis becomes established. That this gastric pain in appendicitis arises in the solar plexus is shown by the fact that the same typical pain is found in all other acute abdominal conditions, gall-bladder, kidney affections, etc.

Vomiting.—Among the reflex disturbances associated with acute appendicitis vomiting is a prominent feature. Its lesser degree and forerunner, nausea, is almost never absent. When vomiting ensues, the sick stomach generally is relieved, though recurrence nearly always takes place. The vomitus at first is the stomach contents; later it may be bile-stained fluid. Continuous and protracted vomiting is rare. Either denotes intestinal obstruction, or gangrene or rupture of the appendix, with a resultant peritonitis. As a rule the physician does not see the patient during the attack until the initial flurry has passed over. Vomiting is one of the early symptoms, occurring about three hours after the generalized pain. If, according to the common custom, some form of purgative is given to the patient as soon as the seizure happens and if, also according to rule, the dose is rejected and then repeated, nausea and vomiting will be prolonged until the physician's visit and then come under his observation. But in all cases inquiry should be made concerning the vomiting, and particularly of its relation to the pain. Invariably the pain precedes the vomiting—a sequence pathognomonic of acute appendicitis, not characteristic of any other abdominal affection. Even after the temporary alleviation of the initial symptoms, each wave of paroxysmal pain which recurs from time to time is followed by a corresponding sensation of nausea, often supplemented by vomiting. So that, although the physician may not have the opportunity of observing the patient during the primary pain and the active stage of vomiting, yet he must obtain, if possible, a clear account of them from the beginning. The cause of the primary nausea and vomiting is the hyperdistention of the appendix by extraneous substances in the lumen or by infiltration of inflammatory products in its walls. In either case the action is reflex through nerve plexuses intimately associated with the stomach. Secondary nausea and vomiting, a lighting up after cessation, point to extension of the inflammation beyond the bounds of the appendix.

Vomiting in the early stage of appendicitis is a valuable sign and at times a life-saver. Following immediately after the pain, it has a significance to the observant physician. The first thought of the inexperienced layman and unfortunately of some unlearned medical men, is to purge the patient; but luckily such drugs are usually nauseating and suffice to renew and increase the vomiting, and the purgative is thrown up, thereby rescuing the patient from a possible perforation of the appendix. Very few could be in accord with the practice of Aitken, who, basing his views upon the assertion of Symonds that "vomiting does not harm," proceeds to administer saline laxatives every hour in suspected but doubtful cases of acute appendicitis until the bowels move, with the purpose of bringing the case to a head. The "movement" in the case he reported induced by the saline "had exposed the danger" and made a correct diagnosis possible. This must be condemned as creating rather than exposing danger and, if a friendly omentum had not previously enveloped the suppurative, but unperforated appendix, the result might have been disastrous instead of felicitous.

Diarrhea may accompany or follow vomiting in an appendical attack—another result of reflex action. Hyperperistalsis in the colon is the immediate cause of the fecal discharge.

Constipation, however, is the usual state, but by no means a constant or essential condition. There is a tendency to believe that constipation is associated with or is one of the causes of appendicitis. Accurate observation will convince any one of the falsity of this belief. Appendicitis bears no relation to the bowel habit of the individual; for it occurs in those whose movements are regular and normal as well as in those who are given to constipation or to frequent stools.

On the contrary when vomiting and particularly diarrhea are conspicuous features of an acute appendicitis the inference is too often formed that they are due to the previous ingestion of food, inappropriate either in quality or quantity, and that it must be evacuated at any and all costs. An attack of appendicitis may, and does come on, in many instances following a heavy meal, or a dietary indiscretion; but the chief agency of the food intake is to produce a sharp stimulus to peristalsis which may precipitate distention in an appendix already crippled or infected. Analysis of a long series of histories will serve to demonstrate that there is no causal connection between the taking of food and the occurrence of acute appendicitis, for in a very large proportion of cases there is no evidence of such association; in many it may be an incident, and in a far more numerous list all sorts of errors in eating have not sufficed to bring about an appendical attack. Nausea and vomiting, then, and sometimes diarrhea, are symptoms of appendicitis, resulting reflexly from lesions of the appendix, and depend not at all upon extrinsic factors.

Tenderness.—The special tenderness associated with acute appendicitis is elicited upon pressure applied directly over the inflamed appendix. Naturally it varies in time of appearance, in grades of severity, and in relative position.

In the early hours of an attack there is superficial hyperesthesia all over the abdomen corresponding to the diffusion of the initial pain. Very soon the cutaneous tenderness disappears and a marked response to finger pressure develops in the right lower abdominal quadrant. Often this will appear before the pain itself has localized in that region. It is vitally important to keep in mind the distinction between pain and tenderness—the first subjective, unrelated to external influence; the second objective, evoked by pressure and modified by its character and degree. More important still is it to realize that the tenderness may be where the pain is not. This is especially significant among the early manifestations, where severe pain commonly is located at the epigastrium or around the umbilicus and marked tenderness is produced by pressure in the right iliac region. In most instances such pressure increases the pain at the point where complaint is made, serving to prove the connection between lesion and symptom.

The degree of response to pressure over the tender area is contingent upon the perceptive impulses of the patient, the period of the disease, the depth of the inflamed part from the surface, and the method of applying the pressure. Much variation exists in the amount of sensitiveness expressed by different persons. The personal psychological reaction enters largely into the matter both in reference to the patient and to the examiner. Heavy-handed attempts to provoke the reaction only defeat the object, while mild but firm laying-on of fingers will elicit existing tenderness, especially if the patient's attention be distracted at the time. A wise plan is to begin palpation elsewhere than in the right abdomen and gradually approach that region last, using the fingers on several parts simultaneously until the distinction is made. In cases where the patient seems to stand the pressure courageously, either from slow response, or stoicism or opposition to treatment, his facial expression can be gradually watched out of the corner of the examiner's eye. Interpretation of tenderness often is a question for a detective rather than a doctor. Its further differentiation is more appropriate for the chapter on Diagnosis.

The tenderness gradually becomes intensified from the time of its appearance and at the end of twenty-four hours generally is at its height. Just as the pain may cease suddenly, or gradually in certain events, so the tenderness may fade quickly or slowly. It never disappears as abruptly as pain is capable of doing; but, when it is very moderate, its pressure may not be discernible after a few hours. In cases where gangrene or perforation occur tenderness may vanish for a time, only to return with the secondary peritoneal involvement.

As an almost fixed rule the nearer the inflamed appendix to the parietal peritoneum, the more acute is the tenderness. This is due, not only to the proximity of the affected area to the abdominal wall, but also to the fact that the parietal is much more sensitive than the visceral peritoneum. Granting that a deeper seated lesion of greater severity were present, its response to pressure would not be so marked as a lesser lesion nearer the wall. Superficial tenderness only would suggest that the pathological process was not in the peritoneal cavity at all, if there is no palpable mass beneath. The intensity of response to pressure may be no index whatever to the extent of the lesion.

The point at which the tenderness exists in its maximum intensity is a question of great interest and moment. As a universally accepted observation this area corresponds to the base of the appendix, for it is there that the nerve distribution occurs with which the afferent nerves from the appendix unite to convey their sensation back to the spinal ganglia. McBurney's point has been the guide to the area of greatest sensitiveness in acute appendicitis ever since it was first announced in 1889. As a matter of accuracy this point is not absolutely over the appendix base, under normal conditions, but McBurney's observations were made from a clinical point of view and not for anatomical precision. In his original statement, as quoted in Chapter I, McBurney located his point "very exactly between an inch and a half and two inches from the anterior superior spinous process of the ilium on a straight line drawn from that process to the umbilicus." Yet there are those who still define this spot as midway between the anterior superior spine and the navel. The truth is, in many cases, McBurney's point represents the place of the acutest tenderness in appendicitis and is a reliable guide when properly elicited. It may fit the actual location of the appendix or it may not. On the other hand, every surgeon of experience knows that there is a wide variation in the exact spot of greatest tenderness, just as the position of the appendix varies both in health and in disease. In determining the sensitiveness to pressure the clinician is more interested in its diagnostic aspects than in its definite anatomical position. First locate the spot by careful palpation and there the appendix will be found.

Other observers have designated "points" which are helpful. Morris suggested an area on the McBurney line just at the outer border of the right rectus muscle. Lanz drew a horizontal line between the two anterior superior spinous processes and located his point at the spot where the right and middle thirds of this line join. Only in two out of twenty cases did it fall exactly upon the appendix. Hertzler, who discusses this question in relation to abdominal topography, finds the base of the appendix to correspond exactly to the common apex of three equilateral triangles within a larger triangle formed by lines drawn, first from the umbilicus to the anterior superior spine, second from the umbilicus to the tubercle of the pubis and then by a line joining the spine and the tubercle. Hertzler believes that his point "corresponds more nearly to the site of the base of the appendix" than Lanz's. In 309 patients Mertens compared the McBurney and Lanz points: 27 were tender at the McBurney only; 88 at both; and 194 at the Lanz point only.

Rigidity.—Muscular rigidity is a superaddition to the tenderness on pressure. It affects the entire abdominal wall, both the recti and the oblique muscles, appearing promptly in the wake of the superficial sensitiveness. Like the pain, at first it is diffuse, but soon concentrates in the right lower abdomen, where it remains. Early light rigidity may be detected in the restricted respiratory movements and in the characteristic drawing up of the right thigh and flexion of the right knee, which the patient voluntarily performs to relieve his pain. This movement relaxes the recti muscles and loosens the iliopsoas.

The palpating hand may now ascertain the increasing tension of the right rectus and lateral abdominal muscles as the rigidity becomes more evident and more localized. Where the tenderness is most marked there is the most intense rigidity, and for the same reason, namely, the greatest area of peritoneal irritation. And whenever the diseased appendix approaches most closely to the parietes, the rigidity will be found. When it is situated far outward or posteriorly, the muscles of the right lumbar region will be rigid; if it points upward toward the liver, the upper abdominal muscles show the rigidity rather than the lower ones; when a pelvic appendix is inflamed, the rectus is stiff low down at its attachment to the pubic bone. A delicate discretion is needed to distinguish between a genuine rigidity due to a pathological process beneath and a voluntary rigidity from malingering or the involuntary type seen in those who through fear or ignorance cannot relax any part of their abdominal musculature. By the utmost finesse only may the difference be determined. In the presence of a fulminant appendicitis the rigidity may be so marked and so persistent that no relaxation is possible. It may not completely succumb even during anesthesia until the incision is about to be made, when the surgeon may judge by easy touch just where the final relaxation takes place. This is of momentous value in locating the appendix and deciding upon the most convenient site for the incision. Beforehand the injudicious and forceful efforts at palpation may be productive of harm. Moreover, it is of no advantage to pursue the investigation deeper; the characteristic rigidity itself may be quite sufficient. Some years ago a physician kept one of his colleagues under observation for three days in an acute abdominal attack and then stated in consultation prior to a proposed immediate operation that he had been uncertain whether the patient had appendicitis, as the abdominal wall was so rigid the appendix could not be palpated. A gangrenous perforated appendix was removed.

Rigidity is both a subjective and an objective phenomenon. It is a reflex action, a protective mechanism to guard against injury or interference. A patient with advanced abdominal rigidity instinctively will put up his hand to ward off pressure or prevent motion, just as the stiffened muscles themselves raise their barriers to defend the inflamed structures inside. Absence of rigidity is not unknown. In mild types or when the appendix is in a postcecal position, the abdominal muscles often show no reflex spasm, even when definite appendical pathology exists. Rigidity may not be noticeable until the attack is far advanced.

Fever.—Some elevation of temperature accompanies every acute infective appendicitis during the first day or two. Along with this there is an increase of the pulse rate. The fever—for such must be defined any rise of temperature above the normal—begins from three to twenty-four hours after the onset of pain. Its average range is from 99.5° F. to 102° F., beginning with the lower reading and reaching the maximum about twenty-four hours after its appearance. In my experience the "appendix temperature" very rarely arrives at 103° F. or over. When the reading is as high as this, notably in the very beginning, other infections are to be thought of, until they are excluded. After a gradual rise in an ordinary attack of appendicitis the temperature hangs around 101° F. for twenty-four to forty-eight hours. If the attack subsides the temperature falls slowly from day to day, until at the end of a week it returns to the normal. A sudden drop in temperature is not a good omen, as a rule; it usually presages gangrene or perforation, following which a fever up to 104° F. may supervene, when an abscess has collected within the peritoneum. Later, if general sepsis develops with its grave pathological extensions, such as pylephlebitis, subdiaphragmatic abscess, etc., the temperature may rise very high and become irregular. Most exceptionally an excessive temperature may usher in an acute appendicitis; this constitutes a serious condition and the prognosis is grave. Chills may occur at any time during the course of the febrile manifestations—practically always in the late septicemic states, not so frequently in the early stages. Cases which I have observed that began with a chill without exception showed a gangrenous appendix. This does not mean that every case of gangrenous appendicitis starts with a chill.

It must be remembered that the initial fever in appendicitis represents an intoxication, absorption of the products of infection, a sapremia; it does not necessarily indicate the presence of pus, even when the temperature registers 102° or higher. Such readings are seen when neither suppurative nor definite destructive changes are noted. Secondary fever coming on after a remission signifies, of course, absorption of pus.

When operation is performed during the first forty-eight hours of acute appendicitis with the temperature around 101° F., generally a reaction follows causing a rise to 102° F. or a little more. This is a natural phenomenon and a beneficent effort, a much more favorable sign than a subnormal range. On the other hand after operation done in the presence of peritonitis and pus collections with a high temperature, 103° F. to 104° F., there is usually a fall, but not sudden or marked.

Fever is not a trustworthy indication in appendicitis. Its presence either in high or low degree gives no token of the severity of the infection; its absence, certainly of any high range, is not incompatible with serious inflammation and grave pathological changes. And yet acute appendicitis can be said hardly to exist without elevation of temperature in some stage. It may not continue or remain constant. Ever to be borne in mind is that, appendicitis once begun with its early moderate fever, the behavior of the temperature afterward furnishes no clew to the progress of the attack, until some secondary change complicates the situation. In cases allowed to go over in an acute attack the subsidence of the temperature is by lysis and not by crisis.

The pulse rate varies between 80 and 120 per minute. In the milder types of infection the pulse may be very slightly altered from normal; usually it keeps up with the temperature, but at times it becomes rapid when the temperature is declining, or gets slower as the fever rises—and both of these are unfavorable tendencies. A slow pulse and a normal or subnormal temperature are often seen in gangrene of the appendix. Very rapid pulse rate, 130 to 140, ensues when peritonitis occurs and the temperature at first high and then below normal, finally may reach 105° F. or above. Taking the pulse in the beginning of an attack, when the patient is in pain or at any time later when he is frightened over the prospect of an operation, may result in finding the rate higher than it would be under quieter circumstances. Not a great deal of dependence can be placed upon the pulse count in nervous, excitable people. When the patient is off guard, or after a period of restful waiting, a more natural interpretation of the pulse can be made, both as to rate and quality. On the whole the pulse is of equal importance with the temperature and it may be even more vital.

Leukocytosis.—In common with other inflammatory processes acute appendicitis exhibits an increase in the white corpuscles of the blood during its progress. This increase may be slight and gradual or marked and sudden; in some cases it declines entirely after a previous rise. The leukocytosis associated with appendicitis has received more general and intensive study than this phenomenon in any other acute surgical disease. As far back as 1899 Fowler referred to the significance of leukocytosis, regarding it "as a fairly constant symptom" of appendicitis but feeling that "its presence or absence without other evidence is not diagnostic." He concluded that it was difficult at that time to estimate its importance, that about the same percentage of leukocyte increase was found in the acute cases without complications as in those accompanied by diffuse peritonitis; and that since the cases in which the leukocyte count was most available were the ones in which it was least needed, it would be of little practical use to the surgeon. Robins in 1900 recommended blood counting as a helpful measure in cases of supposed appendicitis and quotes from Cabot "that a frequent blood count in cases of appendicitis is almost an imperative necessity." Kelly (1905) makes scant reference to the leukocyte count as an aid to clinical diagnosis, stating that the then existing state of knowledge furnished no definite rules. During that year Sondern published for the first time a clear description of the "blood examination in surgical diagnosis." His observations dealt chiefly with the relation of the general leukocytosis to the differential blood-count. According to Sondern an increase in the percentage of polymorphonuclear neutrophils is an index of severe toxic absorption, and the degree of total leukocytosis is an index of the resistance offered by the patient to this absorption. Examinations of the blood of 5,000 healthy adults by Sondern yielded an average leukocytic count of 6,700 per cubic millimeter, and 62 per cent of polynuclear neutrophils.

The "Sondern blood-picture" may be stated succinctly as follows:

Slight increase in polymorphonuclears indicates mild infection.

Decided increase in polymorphonuclears indicates severe infection.

Slight increase in polymorphonuclears with slight leukocytosis indicates mild infection with definite resistance.

Decided increase in polymorphonuclears with decided leukocytosis indicates severe infection with good resistance.

Decided increase in polymorphonuclears with slight leukocytosis indicates severe infection with poor resistance.

Decided increase in polymorphonuclears with no leukocytosis indicates severe infection with no resistance.

Progressive increase in polymorphonuclears with diminishing leukocytosis indicates increasing severity of infection and decreasing resistance.

Gradual decrease in polymorphonuclears with decreasing leukocytosis indicates improvement.

The greater the percentage of polymorphonuclears in relation to the leukocytosis, the greater the probability that pus has formed. This represents the so-called "septic factor." General discussion and successive papers in the literature were precipitated by these observations. A chart was designed by Gibson for comparing the relative total and differential blood-counts according to a normal standard which he set at 10,000 for leukocytes and 75 per cent for polymorphonuclears.

Falkenstein was able to confirm Sondern's views. He found the "picture" to be a sure indication of the severity of the abdominal process and the reaction of the body toward it in every instance, except in children under five years of age.

Deaver's conclusions may be summarized in substance as follows: The variability of the white blood-count makes it a very unreliable guide both in diagnosis and in prognosis; if it be considered as a subsidiary aid and its limitations understood it is of value and should be obtained as routinely as the history and physical examination; operation must never be undertaken or deferred on the basis of the leukocyte count alone.

From a paper by Rice it is convenient to arrange this terse statement: The total white count alone is of questionable value; the polynuclear count alone is of much value; the total and differential count together is of greatest value.

In a comprehensive review of the leukocyte count in acute appendicitis Menninger and Heim, upon the study of 1,945 cases from the literature including 309 of their own, present these general conclusions: The total count is a measure of body resistance up to a certain degree of leukocytosis, the polymorphonuclear count an index of the severity of the pathological process, the relation of the two counts to each other the surest aid toward indications for operation; the best individual resistance is afforded against the less severe pathological processes and relatively poorer resistance is associated with the more severe processes; the younger the patient the better the resistance, becoming noticeably less favorable after the first decade of life; the difference between the resisting power of the two sexes is so slight as to be ignored; the rise of temperature is proportionate to the polynuclear count and to the resistance index, but little variation is noted under 101° F.; no intelligent opinion of the type of organism can be drawn from the resistance estimation on account of the varying virulence of different strains of the same bacteria.

These findings represent fairly the general experience of those who have most to do with appendicitis in all its phases, both medical practitioners and surgeons. They confirm the original work of Sondern and with the observations of those cited above who have followed up their cases in the laboratory, at the bedside and in the operating room. In regard to the blood examination itself it cannot be too strongly emphasized that the differential count in its relation to the total white count is the most essential point, and that a rapidly rising or falling count calls for the exercise of intelligent judgment. Furthermore, at the risk of undue repetition, it must be said again that no indications for operative interference can be predicated safely upon consideration of the leukocyte count alone. Leukocytosis has been put down here as a symptom of acute appendicitis, and it is a more or less constant event—but it is chiefly an ancillary and corroborative phenomenon, helpful materially in the diagnosis, when certain conditions are to be eliminated in doubtful cases and furnishing some guidance to the extent of the disease process.

To correlate the six symptoms which have been named and described, it will be useful to consider them as they stand. The initial pain is almost always followed by vomiting so that we think of them together; at least, definite nausea, if not emesis, is produced. It cannot be too frequently emphasized that pain invariably precedes the nausea and vomiting. Tenderness and rigidity are in partnership, closely allied and rarely dissociated. Fever and leukocytosis naturally are linked together and, according to most observers, proportional to a certain degree. Practically, then, when *pain* is present, we think of *vomiting; tenderness* causes us to look for *rigidity; fever* suggests a *blood-count.* This triple grouping in twos will serve as an orderly means of bringing out the symptoms at the bedside.

Much has been said about the commonly called "cardinal symptoms" of acute appendicitis—pain, tenderness and rigidity. Rightly are they regarded as the essential triad in the appendicitis syndrome. And the greatest of these is pain—first and foremost, beginning elsewhere in the abdomen and settling in the right lower half. Tenderness may not be discovered, rigidity may not appear—but pain is never absent, an unexpected seizure in a person under usual health conditions. We might, therefore, rule out all symptoms except pain, and still have appendicitis. But the typical sequence of pain, tenderness and rigidity puts the diagnosis beyond question. The danger of looking for cardinal symptoms is that sometimes they are actually terminal events. "The only hand that paints a perfect pathological picture is the hand of death."

To the most casual observer it is clear that in acute appendicitis the local signs are of more vital concern than the general manifestations of the disease. Contrast pain, tenderness and rigidity with vomiting, fever and leukocytosis and there is represented another correlation, two groups of three symptoms each, with the greatest emphasis on the first. How necessary it is to elucidate these signs correctly will be appreciated when we come to treat of the diagnosis of appendicitis, by no means a simple matter in the atypical cases.

The frequency of each of the classical signs and symptoms in 367 cases was found by Livingston to be as follows: typical pain, 75 per cent; nausea or vomiting, 70 per cent; rise of temperature, 67 per cent; localized rigidity, 59 per cent; leukocytosis, 76 per cent.

CHRONIC APPENDICITIS

No such orderly or consecutive array of symptoms as observed in acute appendicitis can be assembled in describing the chronic form of the disease. The simple reason for this is that there are no specific symptoms of chronic appendicitis. Its manifestations are protean. Moreover, what is taken to be a perfectly characteristic syndrome may turn out to be derived from an entirely different pathological source. The clinical signs and the diseased processes vary so widely as to forbid any classification of the phenomena which would fit a given case.

In following the course of events in chronic appendicitis much depends upon which view is taken of the origin of the disease: whether it is believed always to result from a previous acute attack, however mild; whether the chronic inflammation unnoticed precedes the lighting up, which excites the investigation; or whether the affection is chronic from the beginning regardless of exacerbations. There are those who advocate each of these three views. The first two might be classed as the recurrent or relapsing varieties, while the last is the true chronic form referred to by most observers on account of the absence of acute manifestations.

Fine distinctions have been drawn between the terms "relapsing" and "recurrent." Some of the earlier writers regarded the relapsing form as a chronic appendicitis in which the acute exacerbations occurred at long intervals and the patient between times was free from symptoms; in the recurrent type the attacks were nearer together and the patient's symptoms were continuous. Later authors defined these terms exactly opposite. There is little to choose between the words themselves. Relapsing is "said of a disease which returns in a new attack after convalescence has begun"; recurrent is "noting symptoms or lesions reappearing after an intermission or remission" (Stedman). The former would suggest, therefore, a more permanent recovery from the acute attack, while the latter indicates a temporary lull with return of symptoms. As a question of practical interest the distinction is of no great value; for 98 per cent of patients who suffer one attack continue to have others; and once an appendix has become diseased it is always pathological even if the clinical attacks are separated.

A few observers, indeed, have denied the existence of the disease known as chronic appendicitis, regarding it as a "myth"; others have looked upon it as a misnomer, not admitting that the inflammatory process can remain without acute signs; others still, while conceiving that the so-called symptoms may be present, cannot agree that it constitutes a pathological entity. Some years ago a medical cynic gave voice to a pointed epigram, which expresses boldly the skepticism toward chronic appendicitis, *viz.*, "There are two kinds of appendicitis: acute appendicitis and appendicitis for revenue only."

Whiteford took up the cudgels against what he termed "the chronic appendix," endeavoring to prove that the symptoms on which the diagnosis of chronic appendicitis is based usually are not properly interpreted, that the microscopic pathology is not to be depended on, that in the majority of cases the symptoms persist after removal of the "chronic appendix," that the effect of wholesale operating in those cases produces a looseness of thought in the surgeon and a loss of faith on the part of the layman and that "chronic inflammation of the appendix as a condition requiring operation should be abandoned."

On the other hand Eastman maintained manfully that chronic appendicitis is a clear-cut disease, not a myth; that it presents characteristic pathological findings; that the symptomatology, while complex and variable, leads surely to its recognition; that removal of the appendix in such cases brings about cure of the ailment from which the patient suffered.

Rouffart contends that the syndrome in chronic appendicitis is typical and easy to determine; he could not understand the difficulty of experienced surgeons in obtaining good results, for in his hundreds of cases he had had no failure; he had seen disaster follow when the clinical picture was not visualized and operation refused; he believes that the therapeutic failures reported by others more likely were diagnostic failures.

Even in infants Maidagan believes chronic appendicitis to be a definite entity with recognizable signs. In the Children's Hospital of Rosario it furnishes 9 per cent of all operations, and the end results are reported as excellent.

Over a long period Deaver has taught that "chronic appendicitis is probably the most common of all abdominal diseases." He even asserts "that it is rare for an adult to possess an appendix that is normal in every respect." This estimate he bases upon the microscopic examination of appendices removed during other abdominal procedures—a test which some other surgeons have rejected as proof of clinical appendicitis.

From the pathologist's point of view Aschoff holds that there is no such condition as an original chronic inflammation of the appendix and that what seems to constitute this affection is a left-over from previous acute inflammations.

Whether chronic appendicitis is due to long-continued irritation of the mucous membrane of the appendix, or whether it always starts from a primary attack, is regarded by Boas, the gastro-enterologist, as a purely academic question. One must agree that if chronic inflammation be present it matters little whence it came or how often its symptoms recur.

The gist of the discussion may be contained in the simple assertion, that there is, of course, a definite disease called chronic appendicitis. As mentioned before, it may result (*a*) from an acute appendicitis, arising in one attack and continuing as a chronic affection with no other acute attack; (*b*) it can exist as repeated attacks of mild type at more or less frequent intervals; (*c*) it may run a chronic course from the first, without acute attacks.

Much confusion comes about from lack of agreement upon questions of terminology. What one would consider chronic appendicitis, another might regard as recurring attacks of the acute form; one might argue that chronic appendicitis could not occur without a preceding acute attack, while another would believe that the disease could originate and continue as a chronic affection. Misunderstanding, also, could arise over the question of whether "inflammation" is always present. Undoubtedly disability may occur and symptoms appear, from adhesions, malpositions and mechanical interference with the appendix, in the absence of inflammation. Yet the symptomatology would be that of "chronic appendicitis." To say that the disease must always result from an original acute attack would mean in every case a definite infection, and narrowing down the chronic type to the same conditions as in the acute disease, making no distinction between them. If "chronic" signifies anything at all, it means of long duration, and here it may imply continuing symptoms, or recurrent paroxysms. Without question a chronically diseased appendix can occur in a patient who has never exhibited any acute symptoms, but only constant signs of mild character; further an acute attack without warning may reveal an inflamed appendix showing evidence of chronic disease extending over a long period of time. Thus, the matter after all is largely one of the character of the pathology. At any time the acute may become chronic, and the chronic may become acute. Associated pathology, too, plays a very important part.

(*a*) Taking up first, the type beginning with an acute attack, and later developing chronic appendicitis, we find, as a rule, that the patient has "never felt quite right since"; he has had an uneasiness in his abdomen, a sort of unrest, which I have interpreted as a "grumbling"; he speaks of "indigestion," "acid stomach," etc.; sometimes he suffers actual pain, which is located at the epigastrium or across the lower abdomen, occasionally in the right iliac area, and is constantly looking for "another attack"; usually he is constipated and his appetite is capricious. If the first attack was called "acute indigestion," the sufferer is complacent; if it was correctly diagnosticated, he is apprehensive. The disturbances may be constant or they may occur intermittently. During quiescent periods neither general nor local signs may be present to account for previous exacerbations. A return of the usual symptoms or a flaring up of an acute attack may exhibit symptoms sufficient to designate the disease. At this time, perhaps, there would be a slight rise of temperature (99.5° F.), a mild leukocytosis (11,500), and probably a tender point in the right iliac fossa, varying with the position of the appendix. After the subsidence of these manifestations, the patient will go on without symptoms, or he will return to his "grumbling." A further study has been made by Menninger, assisted by Holder, of the leukocyte count in ninety-three cases of chronic appendicitis. These observations show a minus resistance figure, further sustaining the principle that the total count represents the body reaction and the polynuclear count expresses the degree of the infection. The ratio between these (resistance index) is plus in the acute type and minus in the chronic.

(*b*) Relapses or recurrences will supervene after shorter or longer intervals according to the character of damage done by the incipient invasion. In many types the first attack is mild and the later ones progressively increase in severity; in others the reverse is true—a marked initial attack followed by attacks which exhibit slighter and slighter signs each time. There may be no let up, however, in the complaints between attacks, which persist regardless of the number or severity of acute exacerbations. In this group of cases, it is more usual, I think, to find a severe attack in the beginning, from which the patient slowly recovered, never quite regaining his accustomed well-being and, in addition to the more or less continuous suffering, being subject to repeated but lesser attacks for a rather long period of time. In my experience it requires on an average about two years to bring such a patient to the operating table. His own suffering or the advancing pathology will suffice to convince him of the futility of delay or the presence of impending disaster. When a light attack starts off the disease and the succeeding attacks become increasingly severe, the patient naturally is more willing to submit to operation, and may ask for it, although the interval symptoms may be less marked and less constant. This only goes to prove what is well known—*viz.*, that the patient is influenced more by pain from which he seeks relief than by any notion of its cause which may demand removal.

(*c*) In the variety which runs a continuous course from the beginning without acute attacks, we find the unqualified genuine chronic appendicitis, whose symptoms are most vague and whose existence has been questioned. It is impossible to lay out any detailed symptomatology—there is none. For the most part the patients manifest "stomach trouble," a variable complaint but usually meaning pain, gas pressure and indigestion. Individuals will express different interpretations of the same signs. The syndrome is strikingly referred to as "appendicular dyspepsia" (Longuet). Seldom do the sufferers advert to the appendical region, though now and then sharp, shooting pains or dull aches are felt there. If too exclusive right-sided suffering predominated, a strong suspicion would be aroused that the appendix was not the source of the symptoms. Chronic appendicitis is concerned with a study of the abdominal reflexes.

Longuet in 1902 was the first to describe what he called *"dyspepsic appen-*

diculaire," which remains to this day as a sufficient title to a widely recognized disorder. This author attributed the symptoms to three types of derangement: mechanical interference with the intestine, due to stasis; reflex disturbances, seen chiefly in pyloric spasm; and toxic absorption from the appendix, exhibited in the general systemic signs. Sherren agrees in the first two theories, but dissents from the last, saying that in the majority of his cases the appendix was thin, fibrous, obliterative or adherent and, therefore, incapable of the absorptive function.

In 33 per cent of the cases reviewed by Heyd, with the chief complaint in the upper abdomen, there had been previous acute attacks of pain properly interpreted as appendicitis; in 80 per cent localized pain at McBurney's point was or had been present; in 50 per cent there was qualitative food dyspepsia, but no relation to any particular food.

Instead of rehearsing abstractly the common symptoms of chronic appendicitis, it might serve better to present a concrete example. Here is the story related to me a few days ago without the interposition of leading questions, by a patient, an unmarried woman of twenty-eight years, who came into the hospital for investigation. Her complaint is "stomach trouble," from which she has suffered as long as she can remember. She particularizes the following symptoms: "indigestion"—an uncomfortable feeling at the pit of her stomach (epigastrium), not actually acute pain, but a distress, which comes and goes irrespective of time or circumstance; gas pressure which also is most marked in the stomach region, going up to her "heart" and later all over the abdomen; loss of appetite, never a sensation of hunger, and a constant fear of eating—because taking food does not relieve but rather aggravates the indigestion, and she is somewhat easier when her stomach is empty; nausea is present, when the "spells" of distress begin, but it is mild, transient and almost never accompanied by vomiting; constipation is the rule with her and she depends upon laxatives; "nervousness" is the last, but by no means the least, of her troubles. The previous history contains only one feature of added interest—typhoid fever at the age of four years. The patient from time to time has left off so many articles of diet, which she believed to disagree with her, that she now lives on raw eggs, cereals and buttermilk. She has lost flesh steadily. There has never been an acute attack; no fever has occurred. The white blood-cells number 12,300 per cubic millimeter. The abdomen is soft and flat on the left, slightly distended at the epigastrium and in the right iliac region, and somewhat resistant at the latter area; the upper right abdomen is negative to pressure; there is distinct tenderness on deep palpation about the middle of a line from the umbilicus to the anterior superior spine of the ileum and, during this manipulation, without suggestion, the patient complains of pain in the lower epigastrium, just above the navel. This is the point of greatest distress when her "stomach trouble" is worse. Through a long right rectus incision all the viscera were examined and found healthy, except the vermiform appendix, which was plastered down underneath the cecum pointing downward and inward, and adherent by its base to the lateral wall of the iliac fossa. It was dissected free and removed. The mucous membrane of the appendix was slate-colored throughout, with a few petechiæ, and its lumen was filled with feces. There was no ptosis of the abdominal organs. Since the operation the patient has gained about eight pounds in weight, her "indigestion" is relieved, and the local signs have subsided. But she is not yet (six months afterward) free from "nervousness."

SUBACUTE APPENDICITIS

This variety of appendicitis is not frankly acute and yet not chronic. Clinically it is represented by those cases just recovered from an acute attack, but not thoroughly well. Pathologically the condition means that the inflamed, damaged appendix has not undergone resolution, although the active stage of infection temporarily has passed. The subacute appendix, in my experience, exhibits exudate causing plastic adhesions to neighboring structures, a very red serous coat and edema of its walls.

Symptoms at this period (a week or more after the cessation of pain, fever and rigidity) include a "soreness," especially upon moving about; difficulty in standing erect; general lassitude and anorexia—all this without the return of an acute disabling attack. Every day or two the patient may feel twinges of pain, passing off quickly. In two weeks or more the acute attack again is likely to light up, the patient in the meantime struggling with the "soreness" in his side. There is no "interval." In fact, the affair is one long drawn out, showing remissions as many another disease does, and the subacute stage indicates an ebb in the pathological tide, only to reach its refluence in due time.

A patient seen for the first time in subacute appendicitis will usually exhibit the same objective signs as in an acute attack, only they are not so marked but latent and repressed. The tenderness is very much less acute, the rigidity diminished or entirely absent, the temperature generally is not elevated, the leukocytosis may be but slightly increased. Yet there is the slumbering appendix already infected, producing the inevitable "soreness" and malaise, ready to start up once more an acute attack.

What I have here described as the "subacute appendix" is not the picture which is drawn by some other writers. Fowler used this term to designate certain cases that were so mild as to be diagnosed "colic" or "indigestion" and also referred to other conditions which are now classified as "recurrent" or "relapsing" appendicitis. He includes, however, cases in which a "true empyema" of the appendix is found corresponding closely with the findings which I have set out above. Kelly places "subacute and chronic inflammatory conditions of the appendix" together under the head of chronic appendicitis, and also a varied class of cases which he called "residual appendicitis." The same term was employed by McCosh "to designate the various deformities of the appendix which may follow acute or chronic inflammation after the active disease has subsided." Very recently Boas used this exact name to express the recurrences of a primarily acute appendix.

Hertzler's "remittent" appendicitis comprises only those cases in which recovery is not complete following an acute attack. Fenger spoke of this type as "postappendicitis." After all it is a matter again of terminology; for under these different titles the identical process, clinical and pathological, is described by various surgeons, each selecting his own word to portray his conception of the condition. I have preferred the term "subacute appendicitis" as expressing practically the state of affairs, as pictured above.

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CHAPTER VII

DIAGNOSIS

If the symptoms of appendicitis were always as clearly defined or as readily elucidated as might appear from the description in the previous chapter, little difficulty would there be in coming to a conclusion. But, unfortunately, in many instances some signs are lacking and other confusing elements are present to blur the image. It becomes necessary, accordingly, to review the symptomatology and to point out the particular features, typical and atypical, which may lead to a correct diagnosis. Along with this direct process it is essential also to bring into the discussion the various and sundry conditions which may be confused with appendicitis, and to study the means by which we may differentiate them. More often it happens that other diseases are mistaken for appendicitis rather than appendicitis is mistaken for other diseases.

ACUTE APPENDICITIS

In a typical, well-marked case of acute appendicitis it is a comparatively easy matter to reach a correct diagnosis. When all the regular signs are present, the merest medical tyro rightly may interpret them. Even the layman has come to recognize the disease both in himself and in his friends. I cannot subscribe, however, to the opinion expressed by some authors that the diagnosis of appendicitis, as a rule, is free from difficulty. Complicating factors may beset, and the absence of one or more common signs may disturb, the examiner's judgment. Doubt will come up even in the ordinary case. In the atypical cases the diagnosis may be a matter of the gravest perplexity, taxing the discernment of the most resourceful and experienced observer. Luckily such instances are not common.

Symptoms.—For the purpose of gaining a clearer insight into the diagnosis of acute appendicitis it seems expedient to rehearse the symptoms in detail, and to discuss their relationship to one another. The symptoms occur in the following order:

1. Abdominal pain
2. Nausea and vomiting
3. Tenderness
4. Rigidity
5. Fever
6. Leukocytosis

Comments on the significance of these symptoms, separately and collectively, may be helpful.

1. *Abdominal Pain.*—Abdominal pain begins at the epigastrium, the umbilical region, the lower abdomen, or as a "colic" all over. Invariably it precedes the other symptoms and usually appears abruptly in a healthy person without warning. After a variable period—three to twenty-four hours—the pain moves downward and to the right, locating with its maximum intensity in the right iliac region. The suffering generally is severe, requiring some form of anodyne for its relief, but usually begins to subside in a few hours and to hold up in thirty-six or forty-eight hours. *If the pain begins over the appendix, the presumption is against appendicitis.*

2. *Nausea and Vomiting.*—Nausea and vomiting, one or both, follow the pain, either immediately or after the lapse of an hour or two. At first the vomitus is composed of stomach contents only and later of duodenal material with bile. Emesis, as a rule, is neither violent nor prolonged, and rarely recurs after its early cessation. Frequently it is intensified by purgatives administered by ignorant members of the family or by witless physicians; but in the patient's favor, for the medicine being rejected, fails to act, and a perforated appendix thereby probably is prevented. The sequence of pain and vomiting cannot be too strongly stressed. The effort of the stomach to empty itself is due to a reflex spasm of the pylorus; the duodenal contraction soon follows; and most likely a violent action of the ileocecal valve.

Constipation is considered the rule in appendicitis, and perhaps this may be the usual state. But diarrhea occasionally occurs, especially just preceding an attack, and more often in children. This may cause the appendix to escape notice. It is by no means the immutable law that appendicitis patients are constipated. Yet many hold this view and further assert that constipation may cause appendicitis. Indirectly this may be true; but it is more probable that appendicitis produces constipation, a vicious circle. When accompanied by diarrhea appendicitis may be very difficult to recognize. A simple intestinal upset causes fever, pain and tenderness, but the latter sign will not be a fixed sensation at McBurney's point and the order of symptoms is variable.

Every acute attack of appendicitis is associated with nausea or vomiting as its second symptom. When emesis ushers in the attack, coming before the pain, one should think first of scarlet fever, smallpox or meningitis—the three diseases that invariably begin with vomiting. *If the vomiting precedes the pain, appendicitis may be ruled out.*

3. *Tenderness.*—Tenderness is restricted to the right lower quadrant of the abdomen and confined particularly to a spot 1½ to 2 inches from the anterior superior spinous process of the ilium on a line drawn from that bony prominence to the umbilicus. This is known as McBurney's point and does not necessarily correspond to the anatomical position of the appendix base, but more nearly to a portion of the cecum above and to the inner side of its junction with the appendix. It does represent, however, the position of sensi-

tive nerve-endings on the abdominal wall, connected with the inflamed appendix, and affords valuable clinical evidence of the existence of acute appendicitis. In a few cases McBurney's point will not be sensitive to pressure, or at least it may not prove to be the location of maximum tenderness, on account of the fact that the appendix is out of its usual position. The spot of greatest sensitiveness then will be wherever the appendix base lies—up under the liver, downward in the pelvis, far out to the lateral wall, or actually in the left abdomen. Finding this tender area by discriminating palpation will lead to a proper diagnosis as well as to an intelligent plan for placing the operative incision. The vast majority of cases show definite tenderness exactly at the point designated by McBurney. *When properly elicited following localization of the subjective pain, this point tenderness is pathognomonic evidence of acute appendicitis.*

4. *Rigidity.*—Rigidity is over the whole right side of the abdomen relagated chiefly to the lower quadrant. It may appear very early along with the initial pain, in which case it is widespread—a general guarding effect against outside interference; soon it may center at a small area directly over the inflamed appendix; later still, if peritonitis, either local or diffuse, develops, the rigid confines include the right iliac region or even the entire abdominal wall. In ordinary cases the most marked rigidity corresponds generally to the neighborhood of the maximum tenderness. The right rectus abdominis muscle often constitutes the most rigid area, even when the tenderest spot is at McBurney's point. Exceptionally the muscle may be the only rigid part with neither rigidity nor tenderness elsewhere. The diagnostic importance of rigidity depends upon the care with which it is elicited. As mentioned before, the utmost subtlety and the most intelligent acumen are to be employed in distinguishing between true and false rigidity, and in observing the location and relative intensity of the rigid areas. A temporary or changeable rigidity would suggest a hysterical origin, perhaps a muscle spasm from slight injury, or general infection; a complete boardlike rigidity coming quickly and remaining without restriction indicates perforation of some abdominal viscus; rigidity in the female equal in both lower quadrants, and especially, if associated with a tender area in the middle just above the pubes, means pelvic infection; rigidity confined to the upper right abdomen calls attention to an acutely inflamed gall-bladder.

But it must not be forgotten that appendicitis frequently exists along with these conditions. The most exclusive negative phenomenon is that the whole left side of the abdomen in acute appendicitis is relaxed, soft, with not a suggestion of rigidity, from the ribs to the pubic arch. *Rigidity is diagnostic, if present; its absence does not preclude the possibility of appendicitis.*

5. *Fever.*—The subjective symptom of fever cuts no great figure in the diagnosis of appendicitis except as between affections of a noninflammatory nature which never cause elevation of temperature and infections of the appendix which as a rule, show some rise above normal. There is no gauge to the height of the temperature. The highest fever may occur in the mildest

cases. At the onset of an acute attack the temperature is not elevated, but before thirty-six hours have elapsed a rise will be noted, if the patient has been closely observed. Taking the temperature is a part of the diagnostic hunt and in conjunction with the other symptoms it is an important guide. It should be noted that some degree of fever is extremely constant; it is moderate, rarely exceeding 102°; it may be absent in a localized abscess already formed, or in a severe diffuse peritonitis, giving definite signs. Chills are not common in appendicitis, but, when they occur in the beginning they prophesy gangrene; late in the disease they signify postcecal abscess or pylephlebitis.

The increase of the pulse rate is roughly proportional to the temperature rise. It is a valuable measure of progress when carefully registered. An advancing rapidity of pulse is a serious sign, no matter how the accompanying symptoms behave. It may indicate the possible presence of some complicating disease, as well as a high degree of toxicity from the organism producing the appendical infection. Contrarily a relatively slow pulse may be noted with profound pathology producing exhaustion; or it may mean some other affection with its characteristic signs. *Elevation of temperature with its accompanying phenomena is to be expected in acute appendicitis.*

6. *Leukocytosis.*—Leukocytosis is of medium grade, a greater or less increase both in the total and polynuclear count. In very mild cases, having clinical symptoms barely allowing a diagnosis, there may be no leukocytosis. In definitely acute attacks of appendicitis the white cell increase is constant, showing an average total count of 12,000 to 15,000 per cubic millimeter with an increase in the percentage of the polymorphonuclear cells. In exceedingly severe cases leukocytosis, general and special, may be absent; so that, in the extremes, both mild and severe, the white blood-count may be conspicuous by its failure to increase according to the rule in the medium type of case.

The fact that the leukocyte count is markedly high in pneumonia, acute pelvic infection and pyelitis makes it unreliable in diagnosis, unless the physical examination and the clinical symptoms be taken into account. The blood-count however, is of great value in separating appendicitis from diseases, like typhoid fever, in which there is a leukopenia, and from other affections which show no leukocytic change. An increase in the white cell percentage will at once exclude these confusing conditions. In each case, whether clear or obscure, the leukocyte count should be taken, if expedient, as a controlling indicator; but in no circumstances, unless in severe doubt, is it right to wait for a rising or falling count, performing frequent punctures upon a patient who needs an operation and not a laboratory study or consultation. It will be recalled that in the preceding chapter a discussion of the value of the white cell-count was given. *Leukocytosis is a strong confirmatory sign of appendicitis, but is not solely to be depended upon.*

Means of Diagnosis.—A diagnosis of acute appendicitis is justified, therefore, upon the symptoms as outlined above, *viz.*, a sudden pain in the abdomen soon localizing in the right iliac region; sick stomach and vomiting; tenderness at McBurney's point; rigidity over the right abdominal area; rise of temperature; leukocytosis. Coming in that order the conclusion is inescapable. It must be emphasized that the local signs are far more important than the general manifestations; that pain, tenderness and rigidity are more diagnostically dependable than vomiting, fever and leukocytosis. This brings us to consider the means or methods of diagnosis. Approaching a case at the bedside first, one should allow the patient to tell his own story. He will very likely refer to his pain as a "colic," beginning "all over" and "settling in the right side." Following this he can be directed to give specific information upon overlooked points without asking him leading questions. He may or may not mention nausea, unless he be prompted, but he will speak of vomiting, if it occurs. The suffering may claim his undivided attention at the time, so that he may not be accurate in locating the points to be noted later. The next procedure would be to ascertain the patient's temperature before disturbing him further. The physical examination is then in order and the abdomen demands prior attention.

Inspection.—Inspection reveals restricted respiratory movements in the abdomen, especially on the right, and in the majority of well-marked cases a flexion of the right thigh toward the abdomen. The former is due to the reflex effort of the suppling nerves to limit the painful excursions of the abdominal muscles; the latter represents the endeavor of the patient to relieve pressure upon the appendix by relaxing the iliopsoas muscle. The patient unconsciously draws up his right knee and usually keeps it in this position.

Palpation.—Palpation is the most essential method of examination. By it is determined the degree, both of tenderness and rigidity, as well as the presence of any mass or growth. One should always begin palpating on the left of the abdomen, away from the suspected side, working up toward the epigastrium and across to the right iliac area. Deep pressure may be required to elicit tenderness in some instances, when the inflammation is mild, or the appendix is posterior to the cecum; while superficial tenderness brought out by gentle touch is found if the appendix is distended, or lying close up to the anterior abdominal wall, or further in cases associated with a localized peritonitis. In the latter condition one of the sure signs is the production of increased pain upon the rebound following deep pressure with a sudden release of the fingers. This offers an irritative insult to the parietal peritoneum. The hands of the practiced examiner will be able to distinguish between tenderness on the surface (hyperesthesia of the skin, muscular reactions, etc.), and that of the abdominal structures themselves. Above all the touch must be soft or else the object of the palpation will be defeated. Going back over the same areas after leaving them for a time, especially while distracting the patient's attention, will serve to correct any hastily drawn impressions. Watching the patient's facial expression out of the corner of the eye is a shrewd stratagem for estimating the effect of pressure. Persistence in prudent palpation distinguishes the experienced and successful observer.

In this connection studies of cutaneous hyperalgesia in appendicitis have been of interest. In 1892 Head published a monograph upon the relation of certain skin areas to visceral disease, and pointed out a distribution of the "cord zones" into segments upon the skin. These "zones" have been suggestive in certain cases, particularly in chronic appendicitis for eliminating or confirming disease in the structure suspected. Sherren studied these zone signs of superficial tenderness with reference to appendicitis, and felt that the skin hyperesthesia test was sometimes helpful in appendical diagnosis, chiefly in relation to an initial attack when in his opinion its absence of sensation in appendicitis denotes gangrene; for the phenomena, he felt, were due to intralumenary pressure. Observations by Szersynski led him to conclude that Head's zones were not absolutely reliable for diagnostic purposes, though they were of some moment. Szersynski suggested an area in which skin sensation varied. This area is bounded above by a horizontal line at the

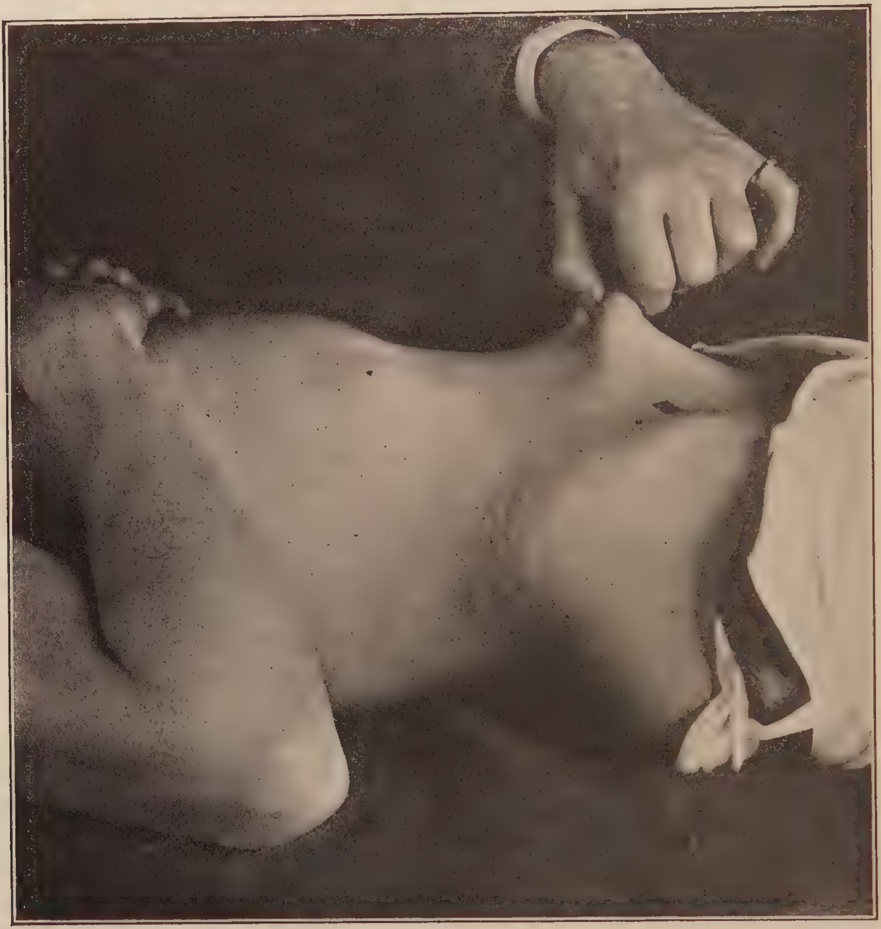

FIG. 27.—TRACTION METHOD OF MAKING SENSORY TEST, ILLUSTRATING THE ADEQUATE STIMULUS (E. M. Livingston, *Archiv. Surg.*)

level of the umbilicus; on the side by the anterior axillary line and the anterior spine of the ilium; below by a line three to six finger breadths below the umbilicus; usually by the outer margin of the right rectus muscle. Of eighty patients 75 per cent showed variations in sensibility, especially when the skin was pinched. The work of Livingston in clarifying the viscerosensory phenomena in acute appendicitis brings out observations of value. In common with others he tested sensory perception by ordinary touch, application of hot and cold tubes, pricking with pin or needle, stroking the skin, pinching with the fingers; but found the last method more satisfactory. He performs what he calls "a vigorous twisting pinch" (Fig. 27), which is exceedingly painful when applied to the involved zone. His sensitive triangle is bounded as follows: above by a line from the umbilicus to the highest point of the crest of the ilium; below by a line from the latter point to the spine of the right pubis; on the inner side by a line from this point back to the umbilicus (Fig. 28). Sensitive skin reactions within this area and intensified at its center are confirmatory evidence of appendicitis; if the sensory perceptions show outside the triangle or exhibit their maximum intensity elsewhere, they become negative testimony for appendicitis. Observations on

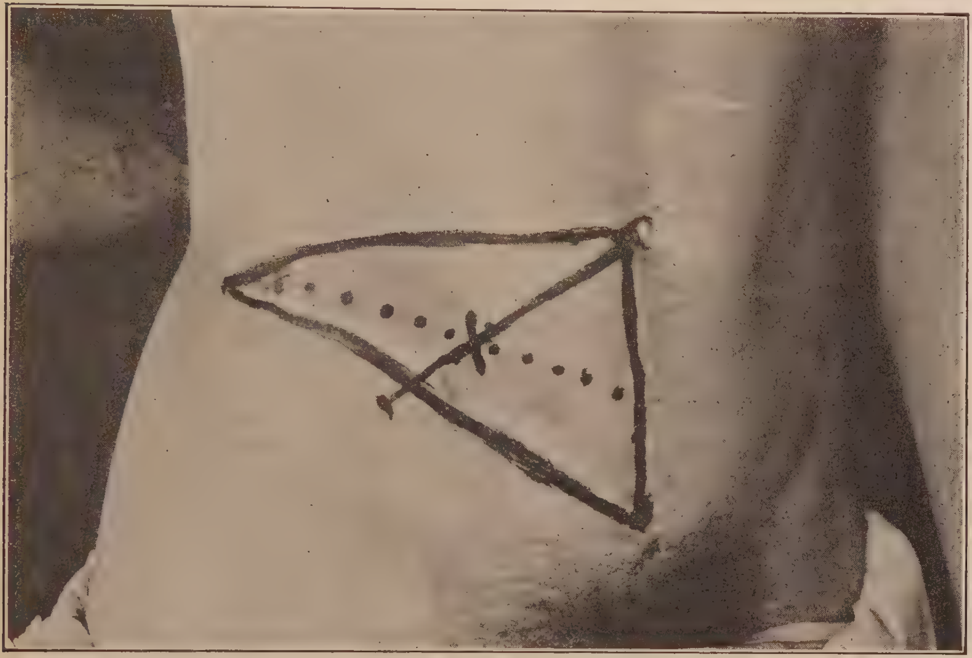

FIG. 28.—SKIN TRIANGLE FOR ACUTE APPENDICITIS

Superior limb of triangle—umbilicus to summit of right iliac crest; inferior limb—summit of right iliac crest to right pubic spine; base of triangle—umbilicus to right pubic spine. The line from the anterior superior spine of the ilium to the umbilicus bisects the triangle. Skin signs present within triangle only and maximal at its center are considered confirmatory of appendicitis (disregarding posterior hyperesthesia). Those maximal beyond this triangle are considered negative for acute appendicitis. (E. M. Livingston, *Archiv. Surg.*)

136 patients proved positive in all but 10 and these did not have appendicitis; 7 were not tested; of the 119 remaining, 101 gave positive signs, and 18 were negative, a percentage of 84.9. "In all negative cases with appendicitis the organ was either gangrenous or ruptured."

A more recent report by Livingston includes over four hundred patients with acute appendicitis in whom 86 per cent showed localized hyperesthesia of the skin. He notes its significance as well in appendicular colic and in secondary involvement of the appendix, does not consider it pathognomonic, but finds it of more value than any other sign or symptom in the diagnosis of acute appendicitis.

Palpation performs an equal service in detecting rigidity. The *tactus eruditus* is surely needed here. One of the most difficult things to acquire is the art of determining the abnormal sense of rigidity as compared to the natural condition. A sense of resistance may be all that is obtainable, yet it may constitute valuable evidence to the trained examiner. Balancing the two sides may demonstrate just enough on the right to pronounce it rigid. Catching the patient off guard will be of similar service as in eliciting tenderness. More often will be found tenderness with little or no rigidity, rather than rigidity without tenderness. For the most part rigidity is a uniform sign and readily evoked.

Percussion.—Percussion will be useful to show dulness in any area, especially in the right iliac fossa, where a mass may be present, consisting of a clumped omentum, an abscess, or even the appendix itself enlarged from inflammation or adhesions. Also tympany, if present, can be elicited and comparison made between the different regions. If the areas are percussed with too hard a stroke the resonant note of the intestines, however relaxed, will be transmitted and alter the sound. Light percussion upon the fingers often will serve no better. Murphy's "piano" percussion is the most successful method—the gentle playing of the fingers in rapid succession directly upon the abdominal wall with the ear held close to distinguish the variations in pitch. By this simple maneuver a mass may be mapped out even in the presence of diffuse tympany from distended intestines lying over it.

Auscultation.—Auscultation is of limited usefulness as a method of examination in appendicitis. Practically the only need for it is to confirm the presence of peritonitis or intestinal obstruction. In such cases the application of the ear directly to the abdominal wall or through the medium of the stethoscope, will determine whether the intestines are in a state of active peristalsis, whether they are without motion or whether they exhibit normal activity. Upon these findings an opinion may be based.

Upon completion of the physical examination of the abdomen the patient's blood is taken for a white count, including the differential percentage. Every physician should be equipped and competent to do a blood-count, or so situated as to have some one else do it, as a matter of routine to prevent errors. Again courting the criticism of wearying repetition, it must be impressed further that a leukocytosis is not necessary for diagnosis or operation, but that it helps us toward a common understanding provided it is accurately done and correctly construed.

Finally certain special examinations may be done. Some of these will be described presently under the section of differential diagnosis. Two will be mentioned here as being the concluding steps in the investigation of a case of acute appendicitis. These are the rectal and the pelvic examinations.

Examination of the Rectum.—Rectal examination proves sometimes to be of great aid, especially in children, in whom a low abscess may be located by the finger through the anus often more definitely than it can be palpated above. Even an isolated inflamed appendix lying over the pelvic brim can be discovered in this way both in adults and in children.

Pelvic Examination.—It is the same with pelvic examinations in the female patient, a procedure that should always be carried out, unless absolutely contra-indicated by a virgin hymen, or for other sufficient reasons. These methods serve not only to check up the probabilities of appendicitis, but also to rule out complicating affairs, which, if present, would interfere seriously with the management of the disease in question. I have known patients who were operated upon under a suspected diagnosis of appendicitis when they really had intestinal obstruction due to a malignant growth in the lower bowel —all because the rectal examination had been omitted.

The lesson to be learned is that a thorough examination of each case is essential and that all means to this end shall be employed. And after all, the diagnosis of disease does not depend upon picking out its individual symptoms, but on the contemplation of the picture as a whole; even the smallest factor that enters in is not to be overlooked.

Use of X-Ray.—The use of the x-ray with opaque meals as a method of diagnosis in acute appendicitis, is, in my opinion, not merely unnecessary, but harmful. Instances of untoward results following this procedure have come to my personal attention. This statement also applies to the subacute variety, cases of which I have seen lighted up into very acute manifestations by the heavy barium drafts.

Differential Diagnosis.—Previous to a discussion of the several disorders with which acute appendicitis may be confounded, it must be admitted that every physician has been confronted with perplexities in its diagnosis, and that every surgeon, besides sharing such uncertainties, has removed a number of appendices which could plead not guilty of the indictment charged against them. Furthermore in a small proportion of cases, no abnormality whatever has been found, either in the appendix itself, in any part of the abdominal cavity, or elsewhere in the body. And this, despite the fact that the symptoms seemed to correspond to those just enumerated and analyzed. The modern generation is looking for a "sign"—and there are sundry signs, albeit not infallible, which will be subsequently described. This only goes to prove that medicine is not an exact science—more's the interest—and that diagnosis is a difficult art, what with individuals showing different reactions to various infections and injuries. It is needful, therefore, to set forth the diseases liable to be mistaken for appendicitis and to enumerate the points of difference. The likeness of some may appear far-fetched, but when atypical instances of each are considered, they will not seem so easy of separation.

One of the common sources of error, not constituting a distinct disease, is an *abnormal position* of the inflamed appendix. Unless this ever be borne in mind misleading features are apt to suggest themselves. When the appendix is situated behind the cecum deeply in the loin or high up near the liver, when it crosses over to the left abdominal region or hangs down in the true pelvis—in either of these events mistakes are likely to happen. Instead of appendicitis one might be more inclined to think of affections of the kidney, of the gall-bladder, of the colon, of the pelvic organs, in accordance with the different locations. Much trouble can be saved by remembering these rather frequent anomalies of position.

So large a number of diseases must be differentiated from acute appendicitis that in order to avoid haphazard consideration, it seems convenient to make the following divisions:

A. Those affections which account for the various causes of pain in the right side.

B. Confusing conditions occurring in other parts or organs of the abdomen.

C. General systemic infections mistaken for appendicitis.

A. Under the first heading will be classed conditions which are nearest to the appendix, and, therefore, earliest to be thought of and eliminated.

1. *Renal Colic.*—This is used as a general term to describe a colicky pain due to a stone in the kidney or the ureter. In this case it begins in the right lumbar region, runs downward along the groin to the testicle and the penis. The suffering is extreme. There is no fever and no leukocytosis. Frequency of micturition exists and following the attack the urine exhibits crystals and blood, perhaps pus. The hematuria is sufficient to be noted by the naked eye. This does not, however, exclude appendicitis. Tenderness in the right iliac region rarely is elicited, except when a calculus is lodged in the ureter; abdominal rigidity may be found during the severe pain, but immediately disappears upon the exhibition of the anodyne which invariably is required. A tender spot may be located in the right lumbar triangle. Often these symptoms exist with urinary sand ("gravel") passing through, and no definite stone. If a calculus is present the roentgenogram usually will show it. A ureteral calculus is more likely to be mistaken for appendicitis than a renal calculus. Cystoscopic examination is demanded in cases of doubt. Retraction of the testicle is occasionally seen in acute appendicitis and Cope reports that testicular pain or discomfort may be observed in 5 per cent of cases in the male.

The relation of the appendix to the right kidney and ureter is discussed by Kreutzmann, who admits that a puzzling group of symptoms on the right side may occur when either of these organs is involved. He reports two instructive cases. The first was a man of forty-nine who had excruciating pain referred to the right testicle and head of the penis, with no abdominal evidence except pressure tenderness over the bladder and right groin; though the x-ray was negative, stone was suspected on account of scratches on the wax-tipped catheter, but operation was deferred in the hope that the calculus might be dislodged; the patient was improved the next day yet he died shortly afterwards, and autopsy demonstrated that the lesion was a gangrenous appendix, lying directly over the right ureter, which was inflamed within and without. The second case was that of a young man suffering with urgent frequency of urine for a period of three months; physical and laboratory examinations were all negative except acute tenderness over the right kidney, running along the ureter and marked at McBurney's point; at operation several days later, there was found a retrocecal appendix, inflamed and adherent densely to the ureter.

Instances of this sort casually turn up. A case similar to the first one reported above will be reviewed under the next section on pyelitis. Many years ago a thin lad gave all the symptoms of stone in an infected right kidney, but without confirmation by the Roentgen ray, which had not then been perfected; exploration of the kidney through the lumbar incision proved futile; an abdominal right rectus incision brought to light a small appendix adherent to the ureter, into which it had ruptured and was discharging intermittently pus and blood. In still another case, exhibiting the same class of symptoms, I cut down upon the kidney posteriorly, only to find it normal, but gratified to discover, glued to it anteriorly upon its pelvic portion, an infected appendix, which I removed through the lumbar incision—the cause of the symptoms.

2. *Pyelitis.*—The pain in infection of the kidney pelvis is not sudden or sharp, but it may become as severe as a nephritic colic. It is usually noticed in the lumbar region, and is confusing only when confined to the right side. Grasping the kidney between the two hands will prove it tender, though this is certainly not to be detected in all cases. Frequency of urination, chills, high temperature 103° or above with a septic run, are the ordinary subjective symptoms. The urine shows pus in abundance, and possibly red blood-cells. The leukocyte count is high. Chief among the diagnostic differences is the usual absence of abdominal signs—no rigidity, no tenderness, no vomiting. At times I have observed a moderate tenderness to pressure in the mid-right abdominal quadrant above, on a level with the umbilicus. It must not be forgotten that appendicitis and pyelitis may exist in the same patient, at the same time. This is due either to a coincidence or to the fact that the pyelitis is a secondary infection from an appendical focus.

Much perplexity will arise in women, who are more subject to kidney infections, and in children who offer greater chances of error. In several instances I have withheld interference, studying the cases for hours, only to find on operation a gangrenous or suppurative appendix placed usually in a deep postcecal position. Records show that the pyuria vanished promptly in these patients after the operation. Pyelitis in such instances is secondary to the appendix infection. Contiguity of structure must be thought of when the appendix is very high and retrocecal. In pregnant women, especially, pyelitis must be kept in mind. It is needless to remark that all urinalyses for diagnostic purposes should be made from catheterized specimens. My invariable rule is that, if pus cells in any amount are discovered in the urine obtained by the natural method, another specimen secured by catheter must be examined. When pus is still present in the latter analysis and the general symptoms of pyelitis prevail, the diagnosis is justifiable. Cystitis, of course, may be assumed when the infectious signs are less prominent, when the frequency of urination with tenesmus is marked and when the urine is alkaline.

Not long ago the diagnosis was missed and a fatal termination ensued in a case coming into our service, presenting an account of four days' previous illness—chills, high fever, leukocytosis, pus and blood in the urine, with no tenderness or rigidity anywhere over the abdomen except a slight sensitiveness to pressure at the suprapubic region later on; operation done too late to be of avail revealed a diffuse peritonitis, the cause of which was a 9-inch gangrenous ruptured appendix adherent diagonally downward into the pelvis, plastered tightly against the under surface of the bladder and reaching by its tip the lower left side of that organ. Difficulties attending the diagnosis of such atypical cases are all but insurmountable. A radiogram furnished no aid whatever, and the use of the cystoscope was, in our opinion, contraindicated.

Acute hematogenous infection of the right kidney must also be thought of.

3. *Dietl's Crises.*—Acute attacks of right lumbar and abdominal pain associated with a movable right kidney are sometimes thought to be appendicitis. These attacks, called Dietl's crises, after Joseph Dietl, an Austrian physician, are attributed to a twisting of the loose kidney on its ureteral pedicle, damming back the urine into the pelvis of the kidney, constricting the blood-vessels and nerves. The spells are paroxysmal in character, often accompanied by nausea and vomiting, occasionally showing a temperature of 101° F., usually preceded by similar attacks, and now and then exhibiting tenderness and resistance in the right abdomen. This affection differs from acute appendicitis in that it comes quickly and goes quickly; that it is relieved forthwith, if the patient lies down and especially if the hips are elevated upon pillows; that it is seen only when the wandering kidney is present; that it occurs overwhelmingly in women, almost never in men; that there are present neither leukocytosis nor point tenderness. The kidney in its abnormal position has been erroneously taken for an appendical abscess. Here again must be remembered the frequent coëxistence of the two conditions. Several authors, indeed, have regarded floating kidney as an etiological agent in appendicitis, on account of its direct pressure, the causing of kinks, or the production of congestion. No observer should allow his opinion to be clouded by the finding of a movable kidney until he has taken the pains to disprove the existence of appendicitis.

4. *Gall-Bladder Disease.*—Manifesting itself in the form either of acute cholecystitis, or so-called biliary colic, or even a rupture of the gall-bladder, diseases of this organ may stimulate acute appendicitis. Resemblance is most noticeable in the beginning of the attack, for the characteristic pain of these affections also begins at the epigastrium, though of a more boring and spreading type, and radiating to the right and back, and upward to the shoulder. Nausea and vomiting, fever, leukocytosis, tenderness and rigidity in the right upper abdominal quadrant, with its maximum intensity just below the tip of the ninth costal cartilage—such are the typical signs of an acute cholecystitis. Biliary colics usually denote attempts of a distended gall-bladder to empty itself, the passage of stones or inspissated bile through the narrow channels of the biliary system; the accompanying pain is very severe, hardly bearable without relief by an anodyne, and upon its subsidence the attack may pass off in a few hours without further symptoms, or signs of acute inflammation of the gall-bladder may develop as outlined above. Rupture of the gall-bladder, a rare and desperate catastrophe, occurring in the course of an acute cholecystitis, is attended with a sudden pain followed by shock, and peritonitis. Later on in the course of these maladies or even in the further stage of an attack, depending on the anatomico-pathological conditions, jaundice may appear; but it is by no means constant and it may be altogether an ultimate sign. Differences between these diseases and acute appendicitis will be found in that they occur at a later average age, and the previous history is not similar, that the pain does not radiate to the right iliac region and that the tenderness is not found there. Warning must be issued that the gall-bladder and the appendix frequently are guilty of simultaneous infection and the question arises, which is predominant. This is an important matter, for it may be imperative to operate at once in appendicitis, while usually it is proper to refrain in cholecystitis until the acute stage has passed. Furthermore, it is recognized that infection in either of these structures may originate in the other and it is an interesting study to determine which is the primary point. More often the appendix is the part first invaded and the gall-bladder becomes the secondary site. In other words cholecystitis more commonly results from appendicitis than the reverse. Ascending infection is the regular order. In my experience about one-third of the cases of biliary tract infection and of appendical disease will show both regions involved.

The distinctive features of the pain in gall-bladder disease are its more intense character, its moving to the back, its paroxysmal type, and its tendency to remain around the starting place, or to progress upward, not downward. Generally the two conditions are not difficult to differentiate.

5. *Acute Salpingitis.*—In female patients many operations have been performed for removal of the appendix when the symptoms—pain, fever, right-sided tenderness and rigidity—were due to acute infection in the pelvis. This is especially confusing when the right fallopian tube only or chiefly is involved.

Ordinarily the distinction is not difficult to make. Acute salpingitis has a definite history of puerperal or venereal infection, of previous attacks, and of menstrual disorders; the pain is gradual in onset and is confined to the lower abdomen; vomiting is rare; the temperature often is as high as 103° F.; careful palpation will show that the tenderness is felt not in the right iliac region near McBurney's point, but lower down and almost equally over the mid-suprapubic region, or in the left iliac area, for salpingitis in the last analysis is a bilateral disease; muscular rigidity is not marked.

But, on the other hand, the history may be vague or unobtainable, the onset can be more or less sudden, nausea and vomiting occasionally occur, the tenderness at times is high and even diffuse when a suppurating area extends upward, and rigidity of a certain degree may exist upon the right and still the condition be acute salpingitis. In such cases the differentiation is perplexing. When the slightest doubt is present one should take time to deliberate, to investigate. This is a matter of great moment; for in acute appendicitis the watchword is early operation, whereas in acute salpingitis it may be disastrous to interfere too soon. Keep in mind for appendicitis the sudden acute pain in the midabdomen, the localized tenderness at McBurney's point and the muscular rigidity over the right iliac region. Unless these signs are present, keep the attention still upon the pelvis. Yet a low pelvic appendix can lead any one astray.

The surest signals in favor of salpingitis are to be elicited through a pelvic examination. Tenderness on pressure in the culdesac is the keynote, especially on pushing up the uterus with one finger. During this manipulation the abdominal hand should not be used, in order to eliminate the pain produced by pressure from above. If the patient complains of acute tenderness from pushing the uterus forcibly upward by the finger on the cervix, one may be quite sure of the presence of acute salpingitis. Finding a fixed uterus with or without masses on each side clinches the diagnosis. Cases of the latter sort represent acute exacerbations of chronic pelvic infection and are much easier to distinguish than the initial acute attacks which present no palpable lesions. The pelvic signs may also be obtained by examination through the rectum.

The temperature and the pulse rate are not distinctive; neither is the leukocytosis. If there is any difference, all three are likely to be much higher in salpingitis than in appendicitis. The patient's facies is also of significance; for the same degree of severity of symptoms the patient looks worse in appendicitis than she does in salpingitis.

In spite of the most solicitous inquiries and the most attentive examination errors are made. Failure to differentiate the two affections may happen in either direction, but more often salpingitis is called appendicitis. Hospital admission slips are loaded with cases sent in with a diagnosis of appendicitis in women and a request for immediate operation, when an intelligent history points to pelvic infection. Perhaps it is just as well that these patients are so regarded, since it is safer to treat them as appendicitis cases, when in doubt. At times these patients are difficult to manage. They feel disappointed at not being operated upon immediately, rebel at the withholding of food and often object to an operation later after subsidence of the acute symptoms. But the mistake should not be made of rushing such cases to the operating table; each one ought to be considered on its own merits. A story was told on a country doctor who was constantly sending patients to a certain hospital, for prompt operation, among them several women, as he thought, suffering from appendicitis, only to be told later that the patient had her pus-tubes removed and was doing well. Later on he sent in a young man with the following note: "This patient has acute appendicitis. I have advised immediate operation—and I'd like to see you find any pus-tube in him."

The simultaneous existence of appendicitis and salpingitis is always to be considered. The one may complicate the other. It is readily appreciated how the appendix may become involved extrinsically at the least, from pelvic infections through the lymphatics in the peritoneal folds or by direct contact of appendix to right tube; but I do not regard salpingitis as so frequently resulting from infection of the appendix, if, indeed, it ever truly happens. It is common enough to find the appendix red, swollen and thickened and adherent to a large right pyosalpinx; and yet this hardly constitutes a typical appendicitis unless its lumen has been invaded. Conversely it could not be maintained that the infected tube was produced by the appendical inflammation. It is possible, of course, for a patient with salpingitis in any form to have at the same time a definite attack of acute appendicitis, and some instances have been reported.

Records from the Oklahoma State University Hospital are quoted by Hayes, showing that in 71 per cent of acute salpingitis cases, appendicitis was present as a complication. Hayes believes that, although it is difficult to distinguish these two diseases, careful attention to the history of onset and to physical signs will clear up many a doubtful case, even before vaginal examination becomes necessary. I have taken the liberty of arranging his practical points of differentiation in the following parallel fashion:

Acute Appendicitis	*Acute Salpingitis*
Starts suddenly in the middle and upper abdomen and travels to the right lower quadrant	Starts slowly in one side of lower abdomen and travels across.
Has no relation to the menstruation.	Acute attacks nearly always follow a menstrual period.
Nausea and vomiting common.	Rarely occur.
Cutaneous hyperesthesia over the distribution of the right tenth thoracic nerve, the first sign.	It is not obtained.
Tenderness and rigidity are localized around McBurney's point or near it.	Tenderness and slight rigidity are found running across the entire lower abdomen.

Acute Appendicitis	*Acute Salpingitis*
Absence of pelvic signs.	Increased vaginal heat, discharge, tenderness or fixation of the uterus, tenderness or masses in the tubo-ovarian region.
Leukocytosis: white count, 12,000–20,000; polynuclear, 85–95 per cent.	Leukocytosis: about 20,000 for first four or five days, afterwards dropping below 12,000; polynuclears usually 80 per cent or less.

Marcus admits only the occasional association of salpingitis and appendicitis and in these cases finds that pain is felt around the umbilicus, in the right iliac fossa and down the right thigh. He stresses the important diagnostic point of the pain at the umbilical region first in appendicitis, and later in the right iliac fossa, but makes an exception of the inflamed retrocecal appendix, which gives usually its initial pain in the latter region. McKenzie's dictum, *viz.,* that lesions of the small intestine cause pain which is usually referred to the middle of the abdomen, is noted by Marcus to explain this phenomenon in acute appendicitis—a point which is probably sound but hardly applicable here, since, though it is admitted that the appendix is on the same embryological and physiological stem with certain portions of the small bowel, appendicitis could scarcely be classed as a lesion of that portion of the intestinal tract. Again in acute infections of the right fallopian tube, as in other affections of the structure, Marcus almost invariably observed pain referred down the right thigh anteriorly, sometimes as far as the right knee; but in none of the numerous cases of acute appendicitis examined by him personally and verified, has pain even been complained of in the right thigh. He explains the difference in the distribution of pain by the fact that the tube is developed as a lateral organ and is represented in the spinal cord by the eleventh and twelfth dorsal and first lumbar segments, while the appendix is mesial in origin and is represented by the tenth and eleventh dorsal segments. Concisely Marcus states that in acute appendicitis pain usually starts in the midline and rarely passes below the groin; in salpingitis it starts laterally and usually radiates down the thigh. On these facts alone he holds that a correct diagnosis can be made. There is general agreement, I think, with these observations, but it cannot be denied that pain down the thigh does occur in uncomplicated appendicitis, and in not such a small percentage of cases. Retraction of the right lower extremity is practiced by the patient to relieve abdominal pain, but beside that there is in the pelvic appendix and in an acutely inflamed appendix lying directly upon the psoas muscle, a distinct pain felt in the groin and down the thigh. Confusion will result if this sign is regarded.

The following differentiating points are presented by Duclaux in favor of salpingitis: It is frequently secondary to abortion or gonorrheal infection; the pain is lower down and is relieved by repose; it occurs close to the menses and the suffering is increased during the period; the uterus is more or less immovable and painful to the touch; rectal palpation confirms the presence of tubal swelling.

In 150 cases a test to differentiate appendicitis and adnexitis was found by Sattler to be reliable. He causes the patient to sit upright on the bed and to raise the extended right leg (with aid, if necessary) while an assistant supports the back to keep it erect. The cecum is then pressed between the abdominal wall and the psoas muscle. In appendicitis a sharp pain is felt at the junction of the right and middle thirds of a line uniting the iliac spines; in adnexitis the painful point is a little lower and further to the right. This appears to be an extra refinement, but it may have as much practical bearing as some of the other "signs."

Mayer and Uhlmann found in appendicitis that the zone of pain which can be demonstrated by sensitiveness to percussion and hyperesthesia of the skin is located ordinarily at McBurney's point, which is the center of a circular area, and its boundaries do not reach to the midabdomen or the inguinal region; while in acute salpingitis this painful zone, best elicited by percussion of the skin, extends to the midline and the groin, and is almost always bilateral, though perhaps differing in intensity on the two sides. These two observers also describe, as commonly present in adnexitis but often completely lacking in appendicitis, certain bilateral hypersensitive zones of skin running straight or obliquely downward from the tenth to the twelfth dorsal segments, from the level of the first lumbar vertebra to the upper third of the cecum.

Examination of the vaginal secretion comes in for emphasis by Wolfring who concludes that, if the seat of inflammation is in the right lower abdomen and the bacterioscopic findings in the urethra, the vagina and in the cervix are of normal type, appendicitis rather than salpingitis may be assumed.

Joseph and Marcus place reliance in the sedimentation test. They found this test normal in acute appendicitis but pathological in acute pelvic infection. In general, they say, the test is positive when larger surfaces are involved. Sedimentation simply means the settling of red blood-cells in a column of citrated blood-plasma and the test is a determination of the rate according to a standardized technic. Baer and Reis state that a negative sedimentation test, over two hours, absolutely rules out pelvic infection.

König observed incorrect diagnoses in 18 per cent of cases sent to be operated on for acute appendicitis and 35 per cent in supposed chronic cases. The female pelvic organs furnished the largest source of error. He insists upon vaginal and rectal examinations in all cases and calls attention to bilateral pain and tenderness as the most important distinguishing features.

In discussing the relations of appendicitis and adnexitis Cumston points out that the only way infection can be borne from the pelvis to the appendix is by back flow through the vessels. Phlebitis first occurs, then lymphangitis. Inflammation goes from the appendix to the pelvis, he believes, by way of Clado's ligament (a prolongation of the meso-appendix merging into the broad ligament and carrying lymphatic channels). Cumston has never seen a woman in whom he could diagnose an inflammation of the appendix by bimanual examination. As pelvic inflammatory symptoms are not so violent in onset, he has more trouble in differentiating a ruptured tubal pregnancy from acute appendicitis than in separating the latter from acute salpingitis. He asserts that the pathogenesis of associated inflammatory lesions of the appendix and the right adnexa has not yet been determined.

A clinical study by Graves caused him to disregard Clado's ligament as a means of conducting infection to or from the pelvis. He believes that three modes of communication exist, *viz.*, by contact, by gravity, and by extension through the cellular tissue. All three of these methods apply to a descending infection from a primary appendicitis to the adnexa; but an ascending infection from the pelvic organs involving the appendix occurs only through contact. Graves believes that "pelvic (adhesive) peritonitis as a result of primary appendicitis is much more frequent than is commonly supposed" and points out the serious gynecological conditions which may come from early acute appendicitis in the female child. To this origin, he attributes many cases of adult pelvic adhesions, ectopic gestation, sterility, dysmenorrhea, genital hypoplasia, etc.

The difficulties of diagnosis are well illustrated by an analysis of twenty-four cases by Ten Berge. His opinion wavered in each case, but he managed them all as if they were acute appendicitis, and only three proved to have acute salpingitis instead; in these three the appendix was involved. In the clean-cut appendix cases, leukorrhea was common; urethritis was present in three, and menorrhagia in eight; in seven there was pain on palpation to the left above the pubes; in three there was intense pain during vaginal exploration. Ten Berge considers examination by vagina and rectum very valuable in acute exacerbations of old processes, where masses may be felt, but notes that in recent infections such enlargements are not found.

It might be added, however, that the exquisite tenderness so marked in these latter types, upon pushing up with the finger against the cervix or posterior vaginal wall, is quite as good evidence of acute pelvic inflammation as the presence of actually palpable masses.

In 150 cases of girls with a diagnosis of acute appendicitis, admitted to his hospital during three years, Scheid reports that thirty proved to be salpingitis or pelvic peritonitis. The clinical history of three of the young girls is instructive: the first, who was thirteen years old, had never menstruated, had a normal appendix but an ovarian tumor with torsion of the pedicle; the second was fourteen years of age, had menstruated for the first time one month before, and exhibited a left pyosalpinx with ovarian cyst and an appendix inflamed at the tip; the third one was thirteen years old and had never menstruated, but was found to have a double pyosalpinx with an enlarged elongated and inflamed appendix. These cases are exceedingly difficult to differentiate, says Scheid, who adds that the condition of the appendix cannot be made definitely clear until the operation is performed.

Another illustrative instance is afforded by the case of a well-developed mulatto girl of twelve years and two months on our hospital service, who showed such unmistakable signs of appendicitis with no distinct tubal lesions, even after careful pelvic examination under ether, that a lateral incision was made, only to find a practically normal appendix and a bilateral salpingitis, binding all the internal genitalia downward and requiring a separate median opening to remove them. The presumption naturally is in favor of appendicitis when doubtful cases arise in young girls, but these instances of pathological precocity must ever be kept in mind.

Difficulty will be encountered in deciding between puerperal infections and appendicitis. It is well known that a slumbering appendix may be precipitated into an acute attack just after a confinement, when uterine or pelvic sepsis may be present. The diagnosis is often masked. Signs similar to those delineated in salpingitis are the guides. Inspection of the vagina and cervix and careful bimanual and rectal palpation furnish the greatest help. A purulent vaginal discharge and a burning pain on urination are suggestive of pelvic infection.

After every precaution is taken and every aid is utilized there will remain cases in which it is impossible to say whether the diagnosis is appendicitis, salpingitis or both. In these circumstances the particular case should be managed as if it were acute appendicitis under the guidance of conservative courage and intelligent delay.

Morison calls attention to *"the pelvic appendix,"* characteristic of which he believes is the absence of severe early pain. Not until the appendix has perforated, generally at the distal end, are urgent symptoms noted. Absence of pain is not special to the pelvic appendix, but is more common in this than in any other variety. The explanation offered is that tension is not present, because this type of appendix can empty itself and the first serious pain results from perforation. Pelvic abscess, he observes, may result from the localization of a diffuse peritoneal infection, from extension of an abscess connected with the appendix in the right iliac fossa, or from a leaking pelvic appendix. Rectal tenesmus is the most suggestive symptom of a pelvic abscess.

6. *Tubal Pregnancy.*—Gestation in the right fallopian tube simulates appendicitis both before, at the time of, and after rupture. The differentiation is more difficult before rupture of the tube, when paroxysmal pain and localized tenderness are present and the true condition is likely not to be suspected. Pelvic examination might or might not reveal a tender rounded swelling alongside the uterus. When rupture or tubal abortion occurs, the sudden stabbing pain with shock, pallor, thready pulse, lowered blood-pressure and possible show of hemorrhage from the genitals, should suffice to point the way. Following the rupture, return of the periodic pain, pelvic pressure symptoms, and palpation of a pulpy mass in the vaginal culdesac establish the diagnosis.

In the separation of ectopic pregnancy from all other conditions the history is of the utmost importance, so much so that if we were forced to choose between an accurate history and the careful physical examination we would rely upon the former. Unfortunately it is not always to be obtained. And there are some points of similarity in acute appendicitis and right tubal gestation. Notwithstanding the contrary observations of some clinicians there is fever in ruptured ectopic pregnancy and the leukocyte count is usually high, both phenomena due to peritoneal hemorrhage with resorption of blood products. Pain, tenderness, and muscular rigidity complete the likeness. The leukocytosis in ectopic pregnancy is not progressive and polynuclear increase does not occur. I have known umbilical, and even epigastric, pain and vomiting to accompany a tubal pregnancy, totally disconcerting the examiner. As a rule, however, it is necessary only to realize that in ectopic pregnancy the signs are those of lower abdominal disease and to rivet attention to that region on the slightest suspicion of this accident. Normal pregnancy should be held in mind, for this is not rarely associated in the beginning with pain due to intermittent uterine contractions; and the mistake has been made of removing an innocent appendix in these circumstances. But the occurrence of acute appendicitis during normal pregnancy is not to be gainsaid.

Neither should the coincidence of appendicitis and ectopic pregnancy be overlooked, though this association seems to be very rare. Pfeiffenberger could find in surgical publications during the past twenty-five years but ten recorded cases. His own case was that of a woman of forty years, who had had two attacks of appendicitis, one eight years and the other four years previously. Beginning with irregular menstruation the patient suffered marked pain, remittent in character, with continued menstrual flow; the cervix was soft, a tender mass was felt behind the uterus, the breasts showed secretion; a diagnosis of extra-uterine pregnancy was made. On admission the temperature was 99.8° F., the leukocyte count 12,600, the right rectus muscle was rigid and there was severe pain at McBurney's point. Diagnosis of acute appendicitis was added. Operation disclosed an inflamed appendix adherent behind the uterus, both tubes free, and a mass in the posterior peritoneal pouch, which proved to be a sac containing a three months' fetus to which the tip of the appendix had been glued. Pfeiffenberger believes that a diseased appendix favors the occurrence of tubal pregnancy and quotes Hammond to the effect that adhesion of the appendix to the fallopian tube arrests the transmission of the ovum and thereby acts as a direct cause of the extra-uterine gestation. In the discussion of Pfeiffenberger's article Harger presented a case which showed at operation a ruptured ectopic pregnancy, forming a mass the size of a fetal head to which was attached an inflamed appendix as large as the thumb. Graves, as before indicated, regards early appendicitis as a causative factor in a later tubal pregnancy. Not only in the acute variety, but also in the chronic types of appendicitis, he conceives that serous exudate may sink into the pelvis, creating tissue changes in the tube sufficient to produce ectopic pregnancy.

Since in both conditions operative interference is indicated, and since in each at times discretionary delay is the better part of valor, it is not a serious matter when diagnostic difficulty of this sort is confronted. Exact refinement of diagnosis may be impossible.

There are other acute pelvic conditions less commonly found but naturally confused with tubal pregnancy and appendicitis, calling for the same treatment—*acute apoplexy of the ovary* and *ruptured hemorrhagic ovarian cyst*. An instance of each is reported by McEwan, who made a tentative diagnosis of acute appendicitis in both cases and proceeded to operate at once, The first case was that of a girl, eighteen years old. She was walking toward the garage to get her car when an acute pain seized her in the right side so agonizing that she doubled up and was carried to the house screaming and vomiting. An hour later the pain ceased suddenly; at operation there was found no appendicitis but a ruptured ovary with profuse hemorrhage, the abdominal cavity filled with blood. The onset in the second case was less sudden—intermittent pains in the right side for four days with nausea and preceding menstrual irregularity for several months, tenderness over the entire lower abdomen and in the vault of the vagina, temperature a little above normal and pulse 103, patient anemic. Diagnosis lay between appendicitis and beginning general peritonitis and ectopic pregnancy; operation revealed a ruptured hemorrhagic cyst of the right ovary.

7. Torsion of the Pedicle of an Ovarian Cyst.—Every experienced surgeon has operated for the relief of this emergency, in some instances under the diagnosis of acute appendicitis. The confusion is justifiable. Acute twisting of the pedicle of a right-sided cyst manifests itself by sudden, agonizing abdominal or pelvic pain, accompanied by nausea and vomiting, fever and rapid pulse, and exquisite sensitiveness to pressure in the right lower abdomen. The diagnosis can be made by recognition of the tumor on bimanual examination, by knowledge of its previous presence and by the low position of the affected area. Cysts of medium size only are liable to torsion. The accident is not uncommon during pregnancy. When the condition is allowed to advance without help, pain ceases, the cyst increases in size, its circulation is cut off, gangrene ensues and a localized peritonitis sets up. It is at this stage that a diagnosis of appendical abscess is likely to be made. In either event operation is demanded. Three cases in our record which were operated on for acute appendicitis and turned out to be acute torsion of an ovarian cyst occurred in young married women and were perplexing because of the rather high position of the involved area. A rare casualty was observed by me in the case of a young girl of nineteen years, referred as acute appendicitis. Just after playing tennis and in her usual state of good health, she was "knocked out" by an overwhelming pain in the lower right abdomen, followed by vomiting, and a temperature of 102° F. with rapid pulse. The lower abdomen was acutely sensitive and rigid all across; by the vagina a very tender mass was made out in the right pelvis. Appendicitis was ruled out in the first round, but kept in abeyance on account of its eminent decency in young women; salpingitis was hardly possible in view of the onset; tubal pregnancy was most probable but not a wholesome diagnosis to be announced beforehand in this particular instance without better evidence. There was found at operation an acute torsion of the right fallopian tube which was about three times its normal size and becoming gangrenous. Twisting of the pedicle may happen also in fibroid tumors both of the uterus and of the ovary, exhibiting the same group of symptoms as described. Here one must depend upon the patient's age, her menstrual history and competent investigation.

8. *Acute Epididymitis.*—When this affection occurs upon the right side, it may cause confusion. Its early phenomena are fever, abdominal pain, and leukocytosis along with tenderness and rigidity near the internal ring, just where the spermatic cord emerges. The tender streak can be traced downward along the groin to the testicle, which will be found enlarged and sensitive. This is sufficient for diagnosis. Yet cases of epididymitis have been overlooked, and the patient prepared for abdominal operation. Several such instances have come under my observation, but in each case the true state of affairs was discovered and no operation was performed. Almost every author registers the same experience. Zipper reported four cases in young soldiers who, already having gonorrheal epididymitis and orchitis, developed symptoms of acute appendicitis. They were treated conservatively.

9. *Dysmenorrhea.*—Without proper inquiry it would be quite possible to mistake menstrual pain for appendicitis. It has been done. At the beginning of a period, before the flow begins, there may be acute pain in the right abdomen, accompanied by slight rigidity, marked tenderness, vomiting and even a moderate rise of temperature. These phenomena may last throughout the period. Usually there are no distinct upper abdominal symptoms. Leukocytosis does not occur.

Castano says that appendicitis may be differentiated from adnexitis by dysmenorrhea occurring in women who have been previously free from it; the suffering is more severe on the right and travels down the leg. He finds appendical dysmenorrhea in 90 [!] per cent of his appendix cases and no signs of pelvic adhesions in these patients.

Kümmel has observed that the beginning of menstruation in virgins is often accompanied by severe pains and abdominal disturbances and he believes that many cases of acute appendicitis have been overlooked at this period, as symptoms were naturally attributed to the genital tract—especially in the absence of the McBurney sign and abdominal rigidity. Kümmel has seen several fatal cases due to this error.

B. Other abdominal conditions likely to be confused with acute appendicitis are next to be discussed:

1. *Perforated Gastric or Duodenal Ulcer.*—When typical cases are seen in the beginning, with definite history and symptoms, little difficulty arises in distinguishing either of these visceral perforations from appendicitis. It is when peritonitis has set in that the greater perplexity comes to determine its origin. In general it may be said that in acute perforations of the stomach

or duodenum the pain is sudden and excruciating, the patient shows marked collapse, the abdominal walls are extremely rigid, actually boardlike; this rigidity and acute tenderness are usually most evident above the level of the umbilicus, but by no means confined to that area; the pulse is rapid and the temperature normal or below normal at first, with a later rise due to peritonitis. The patient's facies exhibits profound shock, his condition is most critical.

By these signs one should be enabled to make out a clear case for perforated ulcer. Of great importance is a previous history of ulcer, but it is not always obtainable, and many patients have had no premonitory symptoms whatever. Reliance must be placed chiefly upon the intensity of suffering, the boardlike rigidity, the "knocked-out" appearance of the patient —conditions which are not usual in appendicitis. If there is doubt of the exact lesion within the abdomen, there could, at least, be no hesitation in applying the test of operation, which is indicated in any event. Whether early or late the call for immediate interference is imperative, and will reveal the condition. When peritonitis has set in there is a general rigidity, extending to the lower abdominal region, and the mistake might be made of locating the incision too low, thinking solely of appendicitis, only to discover the appendix normal. Unless there were extravasated material evacuated above and gravitated below, one might fail to look higher up for the perforated stomach or duodenum. Default in a differential diagnosis is excusable, but neglect to search for the possible lesion is not.

Slow leakage from an ulcer may give rise to symptoms resembling appendicitis, sometimes more puzzling to distinguish than those seen in an acute perforation. Here the preceding history is of great moment and generally is definite, while the signs are restricted to the upper abdomen, and are subacute in character. The presence of a recognizable amount of fluid in the abdominal cavity a few hours after the initial pain is in favor of visceral perforation as against appendicitis. If the fluid is from the stomach, there is rather a widespread distribution; if the duodenum is ruptured the liquids tend to drop down along the outer side of the colon into the iliac fossa and the pelvis. When fluid can be definitely made out, the diagnosis is simplified. But the symptoms of duodenal perforations more nearly resemble those of appendicitis, especially if the cases come under observation after the acute signs are over. Many years ago Moynihan tabulated forty-nine recorded cases, in only two of which was the correct diagnosis made, while in eighteen the first incision was made over the appendix upon a mistaken diagnosis of appendicitis. Although Moynihan repeats this observation in 1905, it is our belief that at this latter date and certainly now, the percentage of correct diagnoses is much higher than the figures of twenty-five years ago. Credit for this improvement as well as for the lowered mortality rate is due to those surgeons who had courage to open the abdomen promptly, to observe the pathological picture, to employ this knowledge for the recognition and relief of subsequent sufferers.

Perforations of other portions of the intestines—the jejunum, the ileum or the colon—are attended with the same relative signs as are seen in perforations of the duodenum or the stomach. No attempt is made here to discuss the causes of these perforations. Our interest centers in them only as their symptoms simulate appendicitis. In all types of perforations the distinguishing marks are those given above. It must never be forgotten that a patient may have perforation of the stomach or intestine and also acute appendicitis at the same time.

2. *Acute Intestinal Obstruction.*—The picture presented by any form of acute obstruction of the bowel often bears striking resemblance to acute appendicitis. It matters not whether the obstruction be caused by volvulus, intussusception, constrictive bands or general adhesions, the clinical symptoms at times are sufficiently similar to cause confusion. If the patient is seen first in the later stages of each affection, the peritonitis period, it may, indeed, be out of the question to distinguish the two etiologically. At the beginning, however, acute intestinal obstruction shows a slow pulse and no rise of temperature, but rather more frequently a subnormal reading; the pain is general and rarely becomes localized at any time; vomiting is continuous and persistent and projectile; the abdomen is distended but not rigid, as a rule; palpation usually is painful but percussion is always painless (Battle); peristalsis is active and sometimes visible; free fluid may be present in the peritoneal cavity; the patient is restless, moving about, having no fixed position of body or legs. A history of constipation for several days or of previous attacks of a like nature may or may not be enlightening. Indicanuria is a fairly constant sign. As soon as complete strangulation of the gut occurs, with fecal vomit, annoying thirst, rapid pulse, diffused peritonitis and ultimate collapse, the diagnosis is assured but the patient's chances for relief generally are gone. The most important thing to remember at this connection is that the appendix itself, acutely inflamed, or chronically adherent, is not rarely the direct cause of intestinal obstruction. This may come about from the encircling of the bowel by the appendix, its adhesion to, or constriction of, the gut by bands attached to both structures—all of which conditions I have observed. When the appendix surrounds any portion of the intestine, the strangulation may be incomplete, since the appendix has pliable, yielding walls and its diameter is larger than that of any bands of adhesion. But the signs of obstruction on this account are no less marked, if not so sudden, and they doubly demand interference.

A favorite place for obstruction by the inflamed appendix is at the terminal ileum, particularly when these structures are agglutinated over the pelvic brim. Obstructive symptoms occur early in such instances and are very marked. It may be altogether impossible and perhaps unnecessary to determine which is the leading factor. Moreover, the condition may occur after operation unless pains are taken to release the constricted ileum along with removal of the appendix. Handley has given a very clear description of this type of obstruction, the commonest cause of which, by far, is appendicitis. When associated with the same condition of the sigmoid flexure he calls it "ileus duplex," or inflammatory enterocolic ileus. He defines it as follows: "Ileus duplex is a condition in which, as a result of a pelvic peritonitis, there is obstruction of the intestine at two points: (*a*) In the ileum at the point about three feet above the ileocecal valve; (*b*) In the sigmoid colon at the junction of its iliac and pelvic portions." When this double obstruction results from appendicitis, the appendix is nearly always pelvic in position, according to Handley, who also joins in the general agreement that pelvic appendicitis is difficult of diagnosis and a dangerous form of the disease. He holds that the recognition of ileus duplex and its proper management will serve to lower appreciably the death rate in this highly fatal complication of appendicitis. From personal experience I can testify to the value of Handley's observations. Before I had occasion to study his paper I am sure that two cases in my service were lost from lack of knowledge of this combined type of obstruction.

It may be possible, of course, to outline a mass at some portion of the abdomen, when obstruction is present—either distended intestinal coils, an intussusception tumor, or a clump of adhesions. But for the most part there is no clew to the local situation. And the obstruction may be of the adynamic type. It may be due alone to fecal impaction, more particularly if the patient be over fifty years of age. In any case the rectal examination should not be omitted.

The sane diagnostic guide is that appendicitis is first, last and always an infectious affair, while intestinal obstruction belongs to the noninflammatory group of disease, mechanical or toxic. In the last stages of both conditions, septic peritonitis duplicates the image; for obstruction means peritonitis and peritonitis means obstruction.

A test for perforative peritonitis has been proposed by Sgambati: "Into a test-tube containing the patient's urine, strong nitric acid is poured as in the ordinary test for albumin, and, if the test is positive, a brownish-purple color appears above the nitric acid for some depth . . . it was never found in intestinal obstruction alone; . . . it appears within two hours after the perforation of an abdominal viscus; but there is a slight reaction the day after any abdominal operation. The chemical significance of the test is not understood."

Concerning the relation of appendicitis to intestinal obstruction Cohn lays stress on a paralytic ileus from an unsuspected perforation of the appendix, and calls attention to the fact that this may not be determined in spite of careful search. His warning is to consider the appendix in every case of ileus of unknown origin. To which suggestion I subscribe.

A case reported by Apfel was that of a male child, aged two years, who had never been ill until two days before when he was taken with vomiting, fever and restlessness. Enemas and cathartics had no effect. There had been bowel movement since the day of his illness. No blood came from the rectum, but the vomitus had a fecal odor several times. Immediate operation showed free fluid in the abdominal cavity with extensive adhesions and a foul, gangrenous appendix adherent retrocecal. Here was a question of diagnosis between appendicitis and intussusception, a matter always uppermost in infants.

Obstruction of the ileum by an inflamed appendix was observed in the following case recorded by Guillanon: A Negro boy fifteen years old gave a history of two days abdominal pain at the umbilicus, no vomiting. Seven months previously he had a similar attack which was overcome by high enemata. He now showed abdominal facies, colicky pains referred to the umbilicus and an intensely painful, tender tumor to the right side, the largest part level with the umbilicus, and moderate abdominal distention. Enemata gave no relief. Immediate operation revealed a large loop of distended ileum, 2 feet long, strangulated by the appendix which was looped around it in a tight ring, and an almost gangrenous tip adherent backward to the base of the cecum, containing a fecal concrement. The tip was freed, the appendix removed, raw surfaces on the bowel sutured and the whole returned to the abdomen. Healing by first intention occurred. According to Guillanon, probably what had occurred was that the long appendix kinked back on itself, forming a loop; the outer extremity was blocked, finally became inflamed and then adherent to the base in consequence; a loop of ileum slipped through the ring so formed and became strangulated.

An illustrative case is presented also by Galbraith and Pollack: A youth of twelve years had severe abdominal pain and vomiting for three days. Purgatives had yielded very slight effect and for the past twenty-four hours no result at all was obtained. An indefinite mass was felt in the right iliac region; the temperature was subnormal and the pulse 118. Diffuse peritonitis was the diagnosis, but its pathogenesis was obscure. On a right pararectal incision, turbid fluid escaped as soon as the peritoneum was opened. The small bowel was distended. The upper abdomen was packed off and the appendix sought for; but, before it was identified, a small band, the thickness of a lead pencil, was felt, stretching from the cecum, under the small bowel, towards the mesentery. This band was seen to be a normal-looking appendix with a short mesentery and with its tip as yet covered by the bowel. Under the appendix was herniated the terminal foot of the ileum collapsed (in contradistinction to the dilated condition of the rest of the small intestine) and with a well-marked constriction ring at each end. The hernia was reduced and the appendix followed to the tip, which was found to be curled, gangrenous, perforated, firmly adherent to the under surface of the root of the mesentery and forming the nucleus of an abscess which had ruptured.

The difficulty in making a differential diagnosis here is at once apparent. I encountered once an almost identical case in which happily the appendix had not quite perforated; but the tip had buried itself deeply in the mesentery, all but going through.

Then, Ferge and Chestnut found an obstruction due to cystic dilatation of the appendix, a large hydrops. Their patient was a man of sixty-seven years, seized by sudden severe pain four days before. During this time high enemata and various cathartics were given without results. There was considerable rigidity, tympanites and vomiting of dark fluid of fecal odor. Diagnosis of acute obstruction was made. Temperature was normal, and pulse was 90. On operation there was seen much distention of the small bowel with gas and fluid. No free fluid nor any sign of inflammation was found in any part of the abdominal cavity. On exploring the right iliac region a tumor was found which proved to be an enormously dilated appendix. The meso-appendix extended down the length of the tumor and was drawn tense by the enlargement and turgescence of the cyst. At the ileocecal junction there was a kink produced by the drag on the meso-appendix. This was severed and ligated and the cystic appendix clamped off and removed at its junction with the cecum. The kink then straightened out without further manipulation. Eight hours later the bowels moved copiously and continued to move regularly thereafter. The tumor was the size and shape of a pear, translucent, with no adhesions or evidence of recent inflammation. The contents, about 5 ounces, was a clear gelatinous material, resembling Wharton's jelly. The opening into the cecum was completely obliterated. The internal surface was smooth and white and showed no evidence of inflammation or ulceration. There is no similar case recorded, say these writers, and there is no description in the common textbooks of the combination of cystic dilatation of the appendix and intestinal obstruction resulting therefrom.

Thus it will be seen that there is a wide divergence between acute intestinal obstruction and acute appendicitis in the ordinary cases, a great resemblance in some and in still others both may be present with the appendix as the causal agent of the ileus. A hair-splitting differentiation is scarcely required and in many instances it will be impossible.

One very momentous affair must never be overlooked, when confronted with acute abdominal pain with or without bowel obstruction. I refer to strangulated hernia of any variety, but especially the inguinal, and on either side, particularly the right. It is an easy matter to pass the hand downward and palpate the groins. By omitting this maneuver errors have been committed. Of the occurrence of the appendix in hernial sacs I shall speak under the heading of complications.

3. *Acute Pancreatitis.*—This rather rare affection presents points in common with acute appendicitis. There are abdominal pain, vomiting and tenderness. But pancreatitis is distinguished first by the fact that its symptoms are all much more exaggerated than in appendicitis: the pain is more intense, the vomiting more persistent, the tenderness more exquisite; besides, there is extreme collapse. Further, the patient is usually an adult past forty years, and the pain is confined to the epigastric area, which becomes resistant to the touch, but not very rigid, and finally presents a mass. Inhibition of the movements of the diaphragm and of the chest with spreading of the inflammation to the peritoneum complete the complex. At first it is plainly an

upper abdominal catastrophe, but when peritonitis develops it becomes general. At any state its differentiation from acute appendicitis may be extremely difficult.

Deaver expresses this difficulty very clearly in his report of the following case: A woman sixty-three years old was admitted with a diagnosis of acute appendicitis. On the morning of the day of admission she was seized with acute epigastric pain which soon became cramplike and generalized. Examination showed a distended abdomen and very little peristalsis, audible only in the upper region; general abdominal tenderness and rigidity, most pronounced in the right lower quadrant; breathing was chiefly thoracic; the white blood-count was 15,000; the temperature and the pulse were slightly increased. Since the diagnosis could not be surely established and the symptoms were not urgent, operation was not performed until ten days later after admission; "a low incision was made through the right rectus muscle; extensive fat necrosis was found, also a chronically diseased appendix, which was removed. Operative diagnosis: acute appendicitis."

The three foregoing conditions, along with certain attacks of acute infection of the gall-bladder and of the pelvic organs previously considered, are the chief affections which are commonly grouped under the term, "the acute abdomen." This expression as employed includes a great variety of things, but it really means little. It represents, in the first place, very faulty nomenclature, loosely constructed phraseology. "Acute abdominal crises," "acute abdominal infections," or "acute abdominal conditions" would be more correct. And the pathological lesions are so varied that no one term can indicate them all. I concur most emphatically in the opinion expressed by Riesman, who blames the surgeons, and I think justly, for coining "the linguistically objectionable phrase 'acute abdomen' to express acute abdominal diseases requiring, as a rule, operative treatment. The abdomen, however, can be neither acute nor chronic any more than a leg or an arm can be acute or chronic." To be sure, the affair is acute and it is supposed to be within the abdomen. And this is the very first and foremost consideration—to be certain the disease is inside the abdomen. Any intelligent means of differential diagnosis has this determination as its basis. We shall have occasion to draw lessons from this theme.

But "the acute abdomen" apparently holds the sanction of usage and it has come to denote a picture common to all sudden abdominal catastrophes, whatever their cause. They exhibit the signs of what Gübler called "peritonism"—pain, shock, vomiting. Following these introductory phenomena, the later course will develop, according to the type of lesion and the organ affected.

To demonstrate the important part sustained by the appendix in acute abdominal disease, it is necessary only to quote the statistics derived by Battle from St. Thomas's Hospital, London, during the three years 1900, 1901, 1902. There were 456 cases, divided as follows:

	Per Cent
Appendicitis and its complications	37
Intestinal obstruction (other than intussusception)	24
Intussusceptions	16
Perforation of the alimentary tract	11
Pelvic cases	6
Abdominal abscesses (other than appendicitis)	3
The remainder	3

Thus it will be seen that appendicitis was the direct cause of "the acute abdomen" in over a third of the cases and, if its relation to intestinal obstruction be considered, a much larger percentage could be assigned to the appendix.

4. *Diverticulitis.*—Outside of its association with some types of obstruction, the condition known as diverticulitis may simulate appendicitis. Acute inflammation of a diverticulum of the sigmoid flexure represents the *acquired forms* and its signs usually are restricted to the left lower abdomen; but they may become general and are then more likely to resemble appendicitis. When the patient is at middle life or older (forty to sixty-five) and the symptoms are largely on the left, sigmoid diverticulitis always should be suspected. Below the age of thirty-five the diagnosis must be looked upon with doubt.

Cases of this sort also occur with symptoms localized in the right lower quadrant, as noted by Telling and Gruner. These writers assert that "this is due mainly to the relative mobility of the sigmoid loop," and that "these cases are, when acute, practically indistinguishable from appendicitis." They also refer to a true diverticulitis of the vermiform appendix, and refer to Lejars and Menetrier, who suggested that this latter condition gives rise to abscess between the folds of the meso-appendix. Left-sided appendicitis, either from visceral transposition or from the "reach" of a long appendix, with a normally placed cecum, ever is to be looked for.

A further observation by Telling and Gruner concerns "epiploic appendicitis"—inflammation of an appendix epiploica, which they believe to result because these tags are hollowed out by a diverticulum, harboring infection or a foreign body, ready to produce perforation with peritonitis or localized abscess. Torsion of an appendix epiploica simulating an attack of acute appendicitis was seen by Helvestine. He judges that this torsion is probably not so rare as the few reports in the literature would indicate, and advises that this condition be looked for when the abdomen is opened on a diagnosis of appendicitis and no diseased appendix is found, although these patients often get well and show no further symptoms. Such cases, he says, may very easily have as the cause of the symptoms an appendix epiploica with a twisted pedicle. With gangrene of these bodies, pain subsides and either absorption or calcification results. When no gross changes can be demonstrated in the suspected viscera, it is well, according to Helvestine, to explore the colon for disease of these fatty bodies, and not relegate these cases to the class in which there is nothing abnormal found.

My concurrence in this advice is readily granted on account of my experience of two cases in which I discovered gangrenous epiploic appendages, one on the sigmoid flexure and the other on the ascending colon. No other lesion was present to explain the symptoms. At the same time, one should not make the mistake of tying off an appendix epiploica, normal or inflamed, on the assumption that it was the appendix vermiformis. Such lapses have been committed with the result of a secondary operation to find and remove the actual offender or with no further symptoms to explain a probably erroneous diagnosis.

The *congenital* form of diverticulitis is seen most often in an inflammatory process occurring in the so-called Meckel's diverticulum. This is found in the small intestine, usually about 2 to 3 feet from the ileocecal junction, although it has been seen at various points from the duodenum to the colon. Its average length is 2 inches; the bowel lumen is narrowed at its origin; its distal end may be free or it may attach itself to other parts of the intestine. It exists chiefly in children. Acute diverticulitis, affecting the pouch of Meckel, results from infection (ordinary intestinal bacteria, typhoid, or tubercule bacilli), foreign bodies, or gangrenous obstruction—precisely analogous to the etiology of the inflamed appendix. Clinically so similar are the attacks to appendicitis that at the onset it is well-nigh impossible to tell them apart. Since the ultimate feature of the acute diverticulitis is intestinal obstruction, and since this is a fairly common, but not inevitable, end of the appendical attack, it may be easier to separate them later. Diffuse peritonitis, occurring in both, may again bring them together. Hare believes that in appendicitis the pain is nearer the median line, usually above and mesial to McBurney's point, or it may be just below the umbilicus, and that muscular rigidity is found at the painful point. There may be blood in the stools, both macro- and micro-scopic. The presence of a preëxisting umbilical fistula, he thinks, is also helpful in the diagnosis.

5. *Tuberculous Peritonitis.*—When tuberculous infection of the peritoneum occurs in the acute form, its resemblance to appendicitis may be such as to deceive even the most careful observer. In the ascitic type, with the abdomen distended by fluid, confusion cannot occur. If, however, suppuration supervenes, diffuse purulent peritonitis may cause one to consider the appendix. When the "dry" form of tuberculous peritonitis exists, faulty diagnoses are more likely to be made; a tuberculous inflammatory mass in the right iliac fossa more than once has been mistaken for an appendical abscess; intestinal ulceration and adhesions of tuberculous type may cause obstruction with pain coursing to the right lower abdomen. Such errors are sometimes unavoidable. In a hospital service for Negroes five cases of acute tuberculous peritonitis were operated upon for appendicitis in one year by three different surgeons.

But it would be very desirable to eliminate the sources of error if possible; for in the dry, plastic variety of tuberculous peritonitis, operation generally is inadvisable. Getting into the peritoneal cavity through adhesions to the parietal peritoneum is difficult; fecal fistula is prone to result if separation of the intestinal coils is attempted; no good, and much harm, can result from efforts to perform operations on these cases. This does not apply to the ascitic type, many cases of which are cured by simple incision, evacuation of the fluid, and closure.

In peritoneal tuberculosis a searching family and personal history usually will reveal some evidence of tuberculous infection. Predisposition is a strong factor. The previous history may bring out alternating diarrhea and constipation, progressive loss of flesh and strength, fever and general malaise before the pain came on. Physical examination should be directed to the whole system; pulmonary tuberculous infection might be found in confirmation of the peritoneal disease. Abdominal palpation presents a "doughy" feel, the presence of multiple masses distributed generally, and usually no definite location of tenderness and rigidity. The blood-pressure is low, the leukocyte count is under 10,000, the patient is anemic.

In any case, where doubt exists or tuberculous peritonitis is suspected, it will pay to take time for investigation. It is better to wait in a possible case of appendicitis than to operate unnecessarily upon a patient with plastic tuberculous peritonitis or to operate at all in the presence of active pulmonary tuberculosis. I speak emphatically upon this point, because a number of untimely blunders of this sort have come to my notice. It is freely admitted, of course, that a patient with tuberculosis of the lungs may have acute appendicitis and that the appendix may be the principal source of a tuberculous peritonitis. Perplexing problems would arise here and a study of each individual case upon its own merits is their only solution.

6. *Thrombosis and Embolism of the Mesenteric Vessels.*—This condition is very rare. Most frequently it is confused with intestinal obstruction, but it is also constantly mistaken for appendicitis. In either issue the differentiation is unimportant, as the indications for treatment are the same. Whether the pathology be due to an embolus in the arterial trunk or thrombus in the vein, the condition is a dangerous one, always leading to gangrene of the gut, and resulting in an exceedingly high mortality with or without surgical attention. Here is the usual picture in mesenteric thrombosis or embolism: A man around forty to sixty years of age is seized by a sudden, agonizing pain in the midabdomen, soon followed by vomiting and extreme collapse; there is great distention of the abdomen, which becomes very rigid and sensitive; when the bowels move the feces show blood, but usually there are no stools, and no passage of gas; the pulse is weak and rapid, the temperature below normal. In a few instances the onset is gradual, the signs little marked and the course rather slow. The demonstration of free fluid in the peritoneal cavity may sometimes be accomplished. There should be no difficulty in distinguishing the typical cases from acute appendicitis. It might be impossible to do so, however, in certain circumstances, especially when the condi-

tion was less precipitate and the patient a younger man, as might occasionally happen.

The points necessary for a diagnosis, as given by Gerhardt and quoted by Battle, may be rearranged as follows: (1) The presence of a source for the embolus and the simultaneous or previous occurrence of embolism in other parts; (2) Colicky pain in the abdomen; (3) Copious intestinal hemorrhages, not to be explained by disease of the wall of the bowel, or by impediment to the portal circulation; (4) A rapid and marked fall of temperature; (5) The possible presence of a mass in the abdomen, due to the infiltration of the mesentery with blood. The only difference to be noted in deciding between doubtful diagnoses in such a condition would be an even more hurried operation, if possible, if thrombosis and embolism were suspected.

7. *Carcinoma of the Cecum.*—Curiously enough cancer of the cecum has been diagnosed and operated upon for appendicitis. It has more often happened in the subacute and chronic types, but also in acute appendicitis the error has been made.

My memory goes back many years to the case of a man, aged sixty, who while at the seashore came down with acute abdominal pain, vomiting and right iliac tenderness, and showed these same signs on arrival at his home, when I saw him in consultation. There was a history of previous similar attacks over a long period. An abdominal mass in the right lower quadrant seemed to complete the diagnosis. It seemed possible to consider malignant disease, and we did; but the patient had fever and leukocytosis. At operation the cecum was far advanced in carcinoma with a slow leak from ulceration. Never since then have I failed to think of cancer of the cecum when confronted with a tumor in the right abdomen in a person of appropriate age, no matter if acute symptoms were present. Twice more have I discovered cancer under similar conditions, but in each case, at least, I suspected it. Another instance came under my care, a recurrent cecal carcinoma, involving the abdominal wall, following operation for appendicitis by another surgeon. Still another case considered beforehand as carcinoma, proved to be a massive inflammatory cecum, which shrank to its normal size after removal of the appendix with no drainage. Generally carcinoma of the colon exhibits a previous failure of health over a long period; unless there is a complicating inflammation neither fever nor leukocytosis are present; often a tumor can be felt which seems out of proportion to the other signs.

A report of five cases between forty-one and seventy-four years was published by Morton, who found a definite diagnosis sometimes impossible, even on opening the abdomen. In three of the malignant cases the condition of the mass found might have been the result of adhesive appendicitis with inflammatory thickening of the adjacent cecal wall, with or without pus enclosed by adhesions, or to malignant growth, and it was not until the adhesions had to a certain extent been broken down that it was possible to make a certain diagnosis.

The almost complete absence of pain in appendicitis, even with abscess formation, was very striking in two of Morton's cases, and the intense hardness with nodulation of an inflammatory appendix swelling in another. In one case the way in which a case of malignant disease may simulate an attack of appendicitis with marked fever is well shown. In all the cases, both inflammatory and malignant, the lump was quite fixed in the right iliac fossa and was situated where the swelling due to appendicitis is very often found. In one of the malignant cases it was at times distinctly tender. On the other hand, a swelling due to appendicitis, even when suppuration is present, may at a certain stage be quite free from tenderness, and the pain may have completely subsided with no pyrexia present, even in the evenings. In one of the cases there was both malignant growth and appendicitis, the latter being due to blockage of the lumen of the appendix by the growth.

In three cases of cancer of the descending colon, recorded by Bailey, there were classical symptoms of appendicitis, including the laboratory and physical findings, and no suspicious signs of malignant disease. The second patient had a palpable tumor which, when found to be a primary abscess, was drained; a fluoroscopic enema afterwards outlined what seemed to be a suspected carcinoma or tuberculosis of the colon.

In Short's opinion it may be difficult to distinguish between carcinoma of the cecum and appendicitis. He had seen a case or two in which the error was made in each direction when a tender mass was palpable in the right iliac fossa. He says it is not well known that there is a solitary ulcer of the cecum or ascending colon, in which there is a painful lump. Such a case was diagnosed as appendicitis by Short and was cured by excision.

What turned out to be an endothelioma of the cecum was discovered in a case reported by De Aragon. The patient, a man of forty years, was thought to have appendicitis, but on opening the abdomen the appendix was found normal. The cecum had a constricting band above the ileocecal valve and a zone of induration in its wall, necessitating a resection. In the lumen was seen a thorn which had been swallowed ten years before.

8. *Rare or Obscure Abdominal Conditions Mistaken for Acute Appendicitis.*—Among the infrequent conditions which have given rise to errors in the diagnosis of appendicitis may be recorded the following:

(*a*) *Intestinal obstruction* by *Meckel's diverticulum* occurring in the same individual and complicated by acute appendicitis was observed by Winn. The patient, a male of nineteen years, was operated on for acute appendicitis. Removal of the appendix was difficult, because the cecum and adjacent portion of the ileum could not be brought into the wound. The ileum was held down by a dense peritoneal band which was about ¼ inch wide. This band was difficult to trace, but was found attached at one extremity to the blind end of a Meckel's diverticulum and at the other end, after winding around a group of intestinal loops, to the mesentery of the small bowel near its posterior attachment. The incarcerated loops could not be released until the band was cut. The diverticulum was 8 inches long, of the same caliber as that of the ileum, both of which were greatly distended, and was given off from the ileum about 3 feet from the ileocecal junction. The constricted intestine had a bluish, lusterless appearance, but returned to normal color when the constriction was released. As the patient was showing shock the diverticulum was dropped back. He returned to work after seventeen days. Next day he was admitted to the hospital with a diagnosis of intestinal obstruction. Operation showed identically the same condition as previously, a band of omentum having become attached to the tip and side of the diverticulum. Several loops of darkly colored distended bowel were incarcerated by the omental band. The omentum was resected and diverticulum removed. Winn felt that the first operation would have been expedited and the second operation probably obviated, had the obstruction been recognized and attended to before the appendix was removed. He explains that the distended gut was not in sight, lying largely within the pelvis and left side of the abdomen, when the abdomen was opened, although it was recognized that the immobility of the ileum was abnormal and it did not seem wise to explore the abdomen until the infected appendix had been disposed of.

(*b*) *Spasm of the small intestine* confused Vogeler in a diagnosis of acute appendicitis. His patient, a man, always well, was taken with a severe pain in the right lower abdomen, with vomiting, and other physical signs pointing to appendicitis. Operation after twenty-four hours showed a normal appendix with a short, tense mesentery. After removal the ileum was found constricted to almost one-half its caliber and could not be freed by manipulation. The parts involving the spasm were painted with a 10 per cent solution of cocain and after four minutes returned to normal.

(*c*) Borch reports two unique cases mistaken for appendicitis. One a boy of thirteen with onset of acute symptoms three days previously which proved to be *osteomyelitis of the sacral hollow of the pelvis* with a collection of thick, fatty sour-smelling pus. The other case in a man, forty-five years old, with onset of acute symptoms eight days before—fever, rapid pulse and a fist-size tumor in the right side. He was very anemic and this led to some doubt as to the diagnosis of perityphlitic abscess. The condition turned out to be an *aneurysm of the abdominal aorta* at the level of the celiac artery.

(*d*) *Occlusion of the descending colon by adhesions from appendicitis* was seen by Rochet and Mallet-Guy in a man aged forty-two, with symptoms of acute appendicitis with pain on the left side. He had had a similar attack one month previously. Operation showed occlusion of the descending colon from adhesions by false membranes from the cecum and the inflamed appendix, and infiltration of the mesentery producing mechanical obstruction of the descending colon. There was an abnormal position of the cecum and appendix towards the left side.

(*e*) *Torsion of the omentum*, simulating an appendical abscess, is the title of a paper by Bulman. His case was one of a woman of forty-four years, taken sick three days before with sudden pain in the right iliac fossa; there were present vomiting, tenderness and rigidity in the right lower abdomen, a tender mass extending upward toward the midabdomen. At operation was found a rolled-up mass of purple, congested and almost gangrenous omentum, its lower extremity disappearing behind the posterior surface of a previously undiagnosed flaccid, unilocular, ovarian cyst springing from the left ovary and occupying the cavity of the pelvis. The left side of the omentum was normal and there was a well-defined line of demarcation between it and the congested portion. It was firmly adherent to the posterior surface of the ovarian cyst. After freeing adhesions it was seen that the congestion was due to a rotation of the right portion of the omentum through half a circle to the left, around a broad base situated at the upper limit of the congested area. The appendix was thickened, bound down by adhesions and chronically inflamed, but showed no sign of recent inflammation. The appendix and the ovarian cyst were removed; the omentum was ligated and excised. Torsion of the great omentum is regarded by Bulman as very uncommon and usually associated with an irreducible right inguinal or femoral hernia. He gives credit to Thomas and Miles for the statement that "in the absence of hernia, torsion of the omentum has usually been mistaken for appendicitis, or for an ovarian cyst the pedicle of which has become twisted."

Cowell recognized the difficulty of this diagnosis and made the following differential points concerning torsion of the omentum: age incidence from thirty-five to fifty-five, more common in the male sex, early pain in the right iliac fossa (85 per cent), vomiting infrequent, pulse 80 to 100, temperature 99° F., a large tumor coming suddenly, rigidity moderate, percussion dull, facies mildly anxious.

Hinton's case in every respect presented the typical signs of acute appendicitis, and yet operation revealed a gangrenous omentum, due to a three-fold twist, and a normal appendix. There was also one large gall-stone.

(*f*) *Rupture of the right rectus abdominis muscle* simulating appendicitis engaged the attention of Harris on account of a case occurring in his practice. A woman, aged twenty-eight, had had epidemic influenza for ten days. Her abdomen was diffusely sore, greatly aggravated by coughing, especially localized in the right lower quadrant. The temperature was 100.5° F, and the pulse 86; there was a sharply defined area over McBurney's point; the leukocytes were 16,500, and polynuclears 80 per cent. The presence of the respiratory infection made the diagnosis difficult, but appendicitis was tentatively agreed upon and operation done. On splitting off the rectus sheath the muscle was to all appearance normal, but on thrusting a pair of scissors into it in order to separate the fibers, the point of the scissors was felt to pass through a superficial layer of muscle into a cavity. On exposure, the cavity was seen to be a space formed by rupture and retraction of the deep layers of the rectus muscle. The posterior two-thirds were involved in the rupture. The two ends were frayed and strands of muscle lay like a fungus in the blood-clot which occupied the space between the separated ends. The peritoneum was opened and no pathologic lesion found in the abdominal viscera. The appendix was normal, but was removed. No attempt was made to suture the ruptured fibers as they were too friable to hold sutures and the intact superficial layer of the rectus was thought to be a sufficient guard against hernia. Rupture of the right rectus in its lower third, *i.e.*, in a position such as might give rise to symptoms of appendicitis, appears to be rare according to Harris's view. It is not mentioned, he finds, as a condition which might confuse the diagnosis of appendicitis in the exhaustive monographs of Deaver, Kelly and Hurdon, or Ochsner; nor did he find it noticed in five other surgical books which he consulted. On the other hand, his investigations show that changes in the muscles are known to accompany epidemic influenza. He refers to Cole (*Brit. M. J.*, 1918, 2:5681) who reports several cases found at autopsy during the epidemic of 1918.

A case of spontaneous hemorrhage within the right rectus sheath simulating appendicitis is the subject of a recent report by Danzis and Soschin. The patient, a woman sixty-four years of age, a chronic sufferer from hypertension, was awakened from sleep twenty-four hours before admission with generalized abdominal pain, locating after several hours in the right lower quadrant. There was nausea but no vomiting. No history of trauma was obtained. Exquisite tenderness and marked rigidity were found; a mass was present; the blood-count showed 10,000 leukocytes and 87 per cent of polynuclears. A probable diagnosis of acute appendicitis was made. A right rectus incision disclosed a large collection of fresh and clotted blood. The abdomen was also opened and a grossly normal appendix removed. Deep mattress-sutures controlled the bleeding in the muscle. Wohlgemuth's report of 127 cases from the literature (1923) is quoted, showing that only twenty of them were actually spontaneous ruptures. Since then six more cases have been recorded. Spontaneous hemorrhage has been attributed to chronic infection, lues, arteriosclerosis, alcoholic indulgence, or purely senile changes. According to Danzis and Soschin "in only 3 cases was rectus hematoma diagnosed correctly," while "in 2 other cases it was suspected."

Hematomas formed by accidental rupture of the deep epigastric artery on the right have been operated upon with a diagnosis of appendicitis.

Abscess within the abdominal muscles has been mistaken for appendical abscess. Its superficial relations, movement with the abdominal walls, and absence of signs within mark the difference. A common cause of abscess in the rectus abdominis muscle is typhoid fever. Occurring during its course or as a sequela of this disease, suppuration in the right rectus may be confusing. Two such instances have come to my attention.

At times an appendical suppuration may extend forward and present on the surface.

(*g*) Massot, Tristant and Caudiere reported an *acute leukemia* simulating appendicitis. A man of fifty-one years had symptoms of acute appendicitis with leukemia. He was operated on at the fifth day and the appendix was found normal with no adhesions and no membranes. Autopsy was refused by the family, so that no examination could be made of the spleen, bone marrow or ganglia.

(*h*) A case of acute appendicitis mistaken for *traumatic contusion* is reported by an anonymous writer in the *British Journal of Surgery* for April, 1914. A lad of eighteen years complained that he was suffering from the effects of a blow on the abdomen received in playing football the day before. About twenty hours after the accident he did not look sick, there had been no severe pain and no vomiting; the pulse was normal, but the temperature was not taken (a fatal oversight, as it proved); there was tenderness and slight rigidity in the right lower abdomen at the site of the injury. He was sent home to rest. Two days later he developed peritonitis and a perforated appendix was removed; death followed on the next day.

Ten years afterwards the same writer saw a boy complaining of pain in the abdomen following a jab with an umbrella in his right side. Remembering the former case the doctor took the temperature and found it was 100° F. An early inflamed appendix was removed.

(*i*) *Unperforated ulcers of the terminal ileum,* symptomatically simulating appendicitis came to Horsley's attention. Three cases are reported, two of tuberculous origin and one of unknown type, all requiring intestinal resection. Each case entered the hospital with a diagnosis of appendicitis and presented the usual signs. In one case the blood-count was not given; in the other two the ratio was 9,400 leukocytes and 69 per cent neutrophils, and 9,000 leukocytes and 63 per cent neutrophils respectively. These observations seem to be the only points of differentiation and they are subsidiary. The means of interpretation between these lesions and appendicitis are admittedly difficult.

(*j*) *Contracture of the psoas parvus muscle* simulating appendicitis forms the basis of a report by White. He had seven cases, with the clinical symptoms of appendicitis, in which he suspected and verified a contracture of the small psoas tendon and found the appendix normal. The complaint in each instance was relieved by tenotomy.

(*k*) *Subcostal neuritis* as a cause of abdominal pain is described by Clinton. The scar of an appendicectomy is frequently seen in patients, presenting this affection on the right, who have been operated upon without relief. The condition is looked upon as a traumatic neuritis due commonly to the repeated squeezing of the eleventh and twelfth intercostal nerve trunks between the tips of the ribs and the wing of the pelvis, and seen in persons who are short waisted or who have an unusually long eleventh or twelfth rib. The pain is of the "toothache type," comes on after rising in the morning and bending over the wash bowl, is elicited by pressure *under* the last two ribs, is relieved by straightening up. Pathologically gross specimens show a neuroma-like swelling in the nerve attached to the rib at the point of injury with a fibrous mass. Treatment consists in resection of the rib for an inch and with it the underlying nerve trunk.

C. General systemic conditions mistaken for acute appendicitis now will claim our attention:

1. *Typhoid Fever.*—To the inexperienced observer, and even to those of wide practice, at the first blush it would seem all but impossible to confound

such dissimilar diseases as appendicitis and typhoid fever. Yet, this error has been committed over and over. In late years it does not occur so commonly, because, perhaps, both of better diagnostic study and also of the diminishing incidence of enteric fever. It cannot be too strongly impressed that abdominal pain often is an early symptom in typhoid fever; that it localizes in the right iliac region, is associated with tenderness and rigidity, is occasionally followed by vomiting. In children the onset is frequently abrupt; it may even begin with a chill. It may be possible in any case to outline a mass in the ileocolic region. But, ordinarily, in typhoid fever the patient has been feeling ill for some time before pain comes on, and only in exceptional instances is the disease abruptly ushered in. Further, usually there is mental hebetude, an enlarged spleen, a history of diarrhea, and a definite leukopenia; after a week or more rose spots and the Widal reaction complete the complex. Very rarely a true appendicitis may accompany typhoid fever and a leukocytosis would be the rule. Differential diagnosis here would be most difficult, and one must depend on clinical observation of the particular case. It is at the very beginning of the disease, before the characteristic signs have appeared, that most of the mistakes have been made.

The simultaneous existence of typhoid fever and appendicitis is readily granted, but the use of the term "typhoid appendicitis" had better be eliminated. For the most part it is merely a confession of error in diagnosis followed by operation which discloses doubtful inflammation of the appendix. Appendicitis may complicate typhoid fever at any time during its course, going even to the stage of perforation, gangrene and abscess. More often it occurs in the later stages or after convalescence has set in. Enteric fever may predispose to infection of the appendix, just as it bears a causal relation to gall-bladder disease. Hardly, however, is there a specific appendicitis caused by the typhoid bacillus or due directly to the disease. In looking back upon the two instances in which I have made the mistake of operating in early typhoid fever for appendicitis I now recognize that there was something in the appearance of the patient, the "feel" of the abdomen and the recital of the history that properly should have guided me. The dull facial expression was not of an acute inflammatory affection; the abdomen did not show a definite area of marked point tenderness and any mass which may have been noted was probably composed of enlarged glands; the particular points in the history were not brought out as clearly as they should have been, and in neither case was a blood-count made. And yet, in the presence of more complete data, errors have been committed by keener clinicians. In neither of my cases did harm result, for the patients went through their typhoid illness without incident. Much to be desired, however, is the avoidance of this oversight.

Provided there is no other cause to explain it, the leukopenia is the most valuable diagnostic point in the very early stages. When leukocytosis is present, typhoid fever is not, unless it exists along with some complicating inflammatory disease, perhaps appendicitis itself.

Unquestionably true typhoid ulcers have been observed in the appendix and perforations of these have occurred during the course of the fever.

2. *Pneumonia, Pleurisy, Empyema.*—These respiratory affections are classed together because they may all be seen in the same patient and any one of them at any time is liable to be mistaken for appendicitis. Although pneumonia and its allied conditions will be discussed under the chapter on Appendicitis in Children, it will not be amiss to present here the general points, for the error has been committed in adult patients.

The essential object is to think of *pneumonia,* never to forget it, and to make a careful examination of the whole patient in every case of acute appendicitis, whether indications of extra-abdominal disease are present or not. Even then, at the very beginning of pneumonia no physical signs may be demonstrable; but at least one's suspicion of chest involvement will be aroused by two things—the bright red flush on one or both cheeks and the playing of the alæ of the nose. In general the respiration is altered both in rate and in type; it is rapid and jerky, and increases in rapidity out of proportion to the pulse and the temperature. This is by no means constant.

Brockman speaks of what he terms the "respiratory-movement persistence ratio." The relation between the degree of abdominal rigidity present and the range of respiratory movement seen, he believes, is a very real aid in distinguishing the conditions. If the pain and resistance be due to infection of the peritoneum, the respiratory motion of the abdomen will be proportionally diminished; but if the rigidity is a reflex from irritation of the lung or pleura, the abdominal movements are not nearly so impaired.

The closest scrutiny and the finest discernment are required further to make a differential diagnosis. If there should be a sudden pain in the side, followed or preceded by a chill, with a rise of temperature to 102° or 103° F. and a cough, one would scarcely be deceived, especially when physical examination showed râles and beginning dulness at the base of the right chest. But, if the pain begins in the abdomen, the chill is absent and the fever moderate, vomiting supervenes and tenderness and rigidity develop over the right iliac region, there would be room for doubt and even some extenuation for a probable diagnosis of appendicitis. Doubt calls for delay in either case. The appearance of the chest signs, which may be belated, rewards one for any hesitation.

Leukocytosis occurs in both diseases, but usually runs at a higher level in pneumonia, especially in the first twenty-four hours; it is not an entirely dependable matter. Also the abdominal sensitiveness and the resistance seem much less prominent and less localized in pneumonia; albeit great distention, marked rigidity and severe tenderness to pressure, closely imitating peritonitis, are not unknown abdominal phenomena associated with pneumonia. Any deviation from the typical signs of a pneumonic lung will serve to obscure the decision. When the full-fledged case of right-base pneumonia develops, there is no longer any confusion.

The real matter is the determination of the diagnosis, if possible, in the uncertain period at the beginning and to refrain from interference pending the decision.

On the other hand it might be argued that, if there is any real doubt as to whether or not to open the abdomen, exploration should be made. For it is abundantly possible to mistake peritonitis for pneumonia and to overlook an opportunity for quick action to save life. In peritonitis, resulting from appendical perforation or other causes, there may occur massive pulmonary collapse, a definite friction rub at the lower chest border, and an increased respiratory rate—which signs might be attributable to chest disease. Moreover, peritonitis is a very rare complication of pneumonia, but it does occur, usually late in the illness. Pneumococcal peritonitis begins early, however, and, unless the pneumonia develops simultaneously or some other clew is obtained, it is practically always mistaken for appendicitis. It is a singularly fatal disease.

What shall be said of an acute appendicitis and a typical lobar pneumonia occurring in the same patient? The diagnosis is arrived at largely after the pneumonia has developed and the appendicitis has become purulent. The former may be of the frank pneumococcic type, or it may be a septic, metastatic form, arising from the appendical infection. In either circumstance the diagnosis remains difficult.

The following parallel summary is modified from Short:

Early Pneumonia	*Appendicitis*
Pain may not be the first sign.	Pain always the first sign.
Pain severe, constant, widespread.	Pain not so severe, paroxysmal at first, more localized.
Vomiting rather uncommon.	Vomiting usual.
Diarrhea common.	Diarrhea uncommon.
Facies anxious; alæ nasi may be working; herpes common.	Nothing special.
Pulse-respiration rate quickened.	Normal relationship (1 to 3½).
Temperature 102°–104° F.	Temperature 98° to 101° F.
Pulse under 100.	Pulse over 100, if temperature is raised.
Tenderness diffuse over right side.	Tenderness over appendix region.
Respiration mostly abdominal, "catchy."	Respiration mostly costal.
Sticky crepitations may be heard.	None.
Rectal examination negative.	Rectal examination perhaps exhibits tenderness.

Pleurisy is subject to the same consideration as pneumonia and, except for its particular physical signs, presents similar conditions for diagnosis. Pain is its chief complaint, present save when effusion forms, and even then frequently represented as a dull ache referred to the top of the shoulder. When the effusion becomes purulent another element is added—a septic factor, which may cloud the diagnosis, if the patient is brought in at this stage. I have saved myself in some instances from opening the abdomen in cases brought in for appendicitis by observing the restricted movement of the chest on one side, which caused me to discover the presence of a thoracic empyema. Pleurodynia, intercostal neuralgia, chest pain of any sort must be ruled out, or confirmed, in any case when appendicitis is suspected.

3. *Other Infectious Diseases.*—Perhaps it is not too much to say that there is danger of every acute infection being confused at some time with appendicitis. In any one of them the onset may be characterized by abdominal pain and vomiting, followed by a rise of temperature. Twenty-four hours' delay will usually bring the decision, whereas hasty judgment may produce an unnecessary operation. Notable mistakes have been made even by experienced surgeons. Practically all of the errors happen in the beginning, since so many of the acute infections have similar initial symptoms and their special diagnostic signs do not develop early. It is only in children, however, that one needs to be on special guard. In Chapter IX particular attention is devoted to the diagnostic difficulties encountered in children.

Now and then *malaria* has been taken for appendicitis. The preceding malaise, the chills, the higher temperature, and the blood examination should suffice. Malarial infection, however, may run in atypical forms, without chills and sometimes with nausea and vomiting and abdominal distress, and the blood findings may be negative. The locality has much to do with the possibility of malaria. McEwan, of Florida, gives an illustration: A young woman, aged nineteen, had vague pains in her right side for a week with tenderness and variable fever, feeling worse every other day. Her physician entertained a diagnosis of acute salpingitis, without making a vaginal examination, and called in consultation another physician who diagnosed appendicitis. Abdominal section was performed, but nothing abnormal was found. No urinalysis or examination of the blood was done. Three days after the operation when McEwan saw the patient, she still had fever and was feeling ill. Plasmodia were seen in her blood and quinin cured her complaint.

Too much trust must not be placed upon a loose diagnosis of malaria. It has been the cloak for hiding carelessness and ignorance, and in two or three instances I have known a serious mistake in diagnosis—appendicitis called malaria—to result disastrously.

In the eruptive fevers and in the general infections, operations are not so dangerous as in pneumonia. Nevertheless surgical interference in such conditions is to be absolutely avoided, if possible; they should be thought of and ruled out, especially in infants and children, before resorting to operation.

Tuberculosis may be confounded with appendicitis. This applies both to the acute and the chronic varieties of each, and patients have had normal appendices removed when the real ailment was pulmonary tuberculosis. I have known of such cases. Indifferent history-taking is responsible for most of these errors. It would be useless to review the symptoms of the two diseases, since they are distinctive enough when adequately brought out. It is understood that appendicitis not infrequently appears in a tuberculous subject and the diagnosis in such a case depends solely upon the findings, as in any other condition, modified by the general infection. According to Armstrong the possible association of appendicitis with pulmonary tuberculosis is not sufficiently emphasized in surgical literature. During a period of two years 12.5 per cent of his patients in private sanatoria were subjected to appendicectomy.

Rarely *herpes zoster* causes an erroneous diagnosis of appendicitis. I have been called to one case of this kind. The sharp neuralgic pain which precedes and accompanies the eruption in "shingles" might very well be misinterpreted in the very beginning, especially when the lowest intercostal nerves on the right side are involved. As soon as the vesicles appear, doubt is dispelled.

4. *Gastric Crises* (*Tabes dorsalis*).—The acute epigastric pain, vomiting and collapse, which occur in tabetic patients might be diagnosed hastily as appendicitis. But in these crises there occur no fever, no tenderness or rigidity of the abdominal wall, and no leukocytosis; besides there are characteristic pupillary changes and absence of the patellar reflex. Rapid-fire conclusions from heedless observations have permitted unnecessary operations in these circumstances.

5. *Lead Colic.*—The very severe colic associated with lead poisoning may sometimes simulate appendicitis. But plumbism, although accompanied by pain and slight vomiting, exhibits a blue line on the gums, absence of leukocytosis and fever, contracture of the abdomen and obstinate constipation. There is a characteristic personal history and occupation. The important signal is the blue line; and it is much more comfortable to find it on the first examination than to have it discovered as the patient is about to take the anesthetic.

6. *Hysteria.*—Neurotic patients, especially women but also men, will often exhibit a good imitation of appendicitis—complaint of pain, the presence of rigidity, and apparent tenderness. It must be noted that the rigidity is voluntary and superficial, disappearing even on deep pressure when the patient's mind is turned away from the examination, also that the tenderness is rarely felt at the exact spot on each renewal of the palpation, if the hands are taken off and reapplied several times. There is no rise of temperature and no increase in the white blood-count. One must, of course, be very mindful to exclude actual inflammation of the appendix and all other organic disorders before announcing a diagnosis of hysteria. Mistakes are not apt to happen in the severe types of appendicitis, when the patient shows signs of grave illness; but it is in the milder forms that perplexity may arise. It is said

that in hysterical patients the patellar reflexes generally are much exaggerated, while the palate reflex is commonly absent (Adams).

"Epidemics" of appendicitis seen in families or households often result from mimicry of the symptoms by those who observe the real sufferers. Francis reported a case of hysterical appendicitis in a girl of nine years who had seen her sister and classmate both having been treated for appendicitis. She declared she had the same symptoms and even appeared to have tenderness over McBurney's point, insisting upon an operation. She was completely cured by inducing slight ether narcosis, performing an imaginary operation, and placing a few adhesive strips and bandages over the supposed site of incision in the abdomen. Granting the diagnostic acumen which is able to detect this counterfeit case, and admitting the good result, it seems questionable to employ the deceptive method in its management. Every physician has to meet these situations and once he makes his diagnosis, he should act accordingly—to operate if appendicitis is believed to exist, and if not, to advise the proper procedure.

7. *Simulation of Appendicitis by Abdominal Symptoms Following Vaccination and Anti-Typhoid Inoculation* is mentioned by Whiteford. Cases came under his care in which on account of acute abdominal pain, vomiting and fever, a diagnosis of appendicitis had been made. When the fact of a recent vaccination came to light each case was soon cleared up.

8. *Acute Alcoholic Poisoning.*—"The False, Acute Surgical Abdomen on an Alcoholic Basis" is the heading of a paper by Brams and Vaughan. They present evidence to show that acute alcohol poisoning may produce a clinical picture closely resembling perforated peptic ulcer, appendicitis, or acute gallbladder disease—the usual causes of the "acute surgical abdomen." Alcoholism manifests shock, leukocytosis, abdominal pain and rigidity. Thoughtful investigation and clinical experience are essential to avoid errors. These writers are inclined to ascribe the abdominal symptoms to various denaturing agents employed rather than to the ethyl alcohol itself.

Comment.—Summing up briefly the differential diagnosis of acute appendicitis it would seem that the possibilities and vagaries of the problem are without limit. Some of the comparisons and many of the mistakes appear to be far fetched; yet there are constant sources of error and numbers of pitfalls ready to trap the most wary. Many with little experience are perfectly confident that they could not confuse appendicitis with any other abdominal affection, much less with diseases outside the peritoneal cavity, while those of a longer period of practice are more apt to feel doubtful in expressing a positive opinion. The percentage of error in the work of any one surgeon or any particular hospital or clinic will depend somewhat upon a certain luck in the run of cases, but largely upon the care taken to study the individual patients. A personal record of the success and failures in diagnosis is seldom kept and rarely published. In a recent report of observations on a thousand appendicectomies Field states that in about 80 per cent of his cases the preoperative diagnosis of acute appendicitis, confirmed at operation, was made with confidence; in about 10 per cent more the diagnosis, made with some misgiving, was found correct at operation; while in the remaining 10 per cent the diagnosis was incorrect—either some other lesion was found or none at all to account for the symptoms. As most of the cases needed operation anyway, he believes no harm was done.

It would be well if some surer methods could be determined for differentiating acute appendicitis from its simulating affections. As it is the most common of all the acute abdominal conditions, naturally it is the first thought of, and in the greatest proportion it will be found. Later certain eponymic "signs" will be described; they are by no means pathognomonic, representing personal observation applied to particular phases of appendical distress, both acute and chronic. At present there is no known instrument of precision which unerringly will decide that a given attack is appendicitis. X-ray study with the aid of the opaque gastro-intestinal meal, which holds a degree of usefulness in chronic appendicitis, may not be employed with impunity in the acute type. Indeed, it would be contra-indicated in the inflammatory stage of appendicitis under any conditions, for fear of aggravating the symptoms or producing a perforation. The same objection would apply to any other acute abdominal condition. Roentgenological examination, however, is of eminent value for detecting possible calculi in the genito-urinary tract, foreign bodies anywhere in the abdomen and, to a much less degree, stones in the gall-bladder or ducts. In doubtful cases elimination of these factors goes a long way toward relieving the difficulty.

So, the diagnosis is justified by keeping constantly in mind the principal points of acute appendicitis, by thinking of other affections which could cause similar symptoms, and by eliminating these as promptly as possible in the light of known comparisons.

CHRONIC APPENDICITIS

Conceding the difficulties in the diagnosis of acute appendicitis, for a stronger reason chronic inflammation of the appendix affords even harder problems. Its causes are less understood, its pathology less stable, its symptoms less defined and its types less fixed than in the acute form. The symptoms of chronic appendicitis as outlined in the last chapter constitute a firm basis upon which a diagnosis could be made; but these identical complaints are observed in several other diseases. To diagnosticate chronic inflammations of the appendix, one must be prepared to eliminate all the various conditions with which it may be confused or associated, rather than to depend upon any group of constant signs of its own. I am conscious of no more perplexing diagnosis in the realm of medicine. It can be made intelligently and honestly only by a process of exclusion, by seeing that all complicating elements are ruled out, and finally indicting the appendix with the clearest circumstantial evidence.

Omitting the two varieties in which attacks occur—the one beginning as an acute and developing into a chronic ailment, and the other starting as a low-grade chronic infection and becoming acute—it will serve a better purpose to direct our entire attention to the third type, the real chronic appendicitis, occurring without acute attacks. This is the condition referred to in the preceding chapter as a "myth" in the words of some and just as valiantly defended by others. Its diagnosis depends on the following factors: "Stomach trouble," "dyspepsia," "indigestion"; distress at the epigastrium, or in other regions of the abdomen; constipation, rarely diarrhea; nausea, and at times vomiting, gas pressure, very seldom hematemesis; loss of appetite, flesh and strength.

What has been called "appendix dyspepsia" is a vague and variable picture. Yet nevertheless it is an actual entity. The epigastric distress is increased by exercise, and bears no constant relation to food; at one time the stomach feels better without food, and another time better with it; certain articles may upset the stomach one day, when on another day these may agree. Its most impressive phenomenon is the occurrence of pylorospasm, a contracture of the pylorus, accompanied by pain in the upper abdomen, hyperacidity of the stomach, eructation of sour material, and occasional vomiting. By x-ray examination and by observation at the operating table the spasm of the pylorus may be demonstrated. When it is of long standing it results in a dilatation of the duodenum, that persists until the cause is removed. The adherent constricted, obstructed, or thick-walled chronically inflamed appendix may be the sole origin of the dyspeptic symptoms.

Such a diagnosis, to repeat, can be accomplished by a process of elimination, for other conditions may give rise to the same symptoms. Methods and means are to be employed systematically to determine if different diseases beside appendicitis can account for the symptoms. The appendix must be held innocent until proved guilty. A complete history is the first step, going over the previous personal story, and the present symptoms in detail. Then should follow a general physical examination, taking note of the condition of the chief organs of the body, searching for every possible focus to explain the suffering, and including any special laboratory methods suggested as the investigation proceeds. The object of this process is not only to confirm or to rule out chronic appendicitis, but also to discover other ailments which may complicate it, or which may exist in its stead to explain the symptoms.

It is no longer possible for a physician unassisted, examining a patient in his office, to make a proper diagnosis of a chronic appendicitis. He can obtain much information, however, by a painstaking palpation of the abdomen, finding the state of all the viscera and confirming the appendical involvement. A study of the abdominal reflexes is the important matter. Pressure over the appendix usually is not painful, but the pain may be felt somewhere else—at the umbilicus, in the epigastric region, over toward the left iliac, down into the pelvis, or up under the liver. The general rule is that the pain is reflected to the spot where the patient usually feels the distress or aching and very often during the pressure over the appendix, which itself may not be sensitive, with no suggestion, he will cry out that the examining fingers have reproduced the pain in the spot (epigastrium, lower abdomen, etc.) where it always begins. This is almost a positive confirmation. It behooves every examiner to go over the abdomen very carefully, inch by inch, until he elicits whatever information is available.

One must not expect to find the appendix very tender in the absence of any inflammatory attack, or any recent disturbance. It is well to keep away from the right iliac region until every other part has been explored; it is easy for the patient to volunteer local signs. There is no reason to look for acute tenderness over the appendix. This is explained clearly by Morris: "I have seen many consultants make pressure over the appendix at McBurney's point, and decide that the patient did not have a chronic appendicitis because there was no tenderness on pressure at that point. Tenderness at McBurney's point belongs to acute appendicitis. It is seldom present in chronic appendicitis." He goes on to describe another tender point (Morris's point) brought out by deep pressure, 2 inches to the right of the umbilicus and a little below it, and adds: "On the other hand tenderness on pressure at this other point near the navel is not present in acute appendicitis. It belongs to chronic appendicitis."

Pain wholly restricted to the right iliac region and constituting the only sign, at once raises a presumption against appendicitis. It does not mean very much as far as the diagnosis is concerned. Yet many writers lay great store by the right iliac pain, and especially the tenderness. In reporting an instance of abdominal pain relieved by removal of an apparently healthy appendix Larson depicts the case of a young girl, aged fourteen, who came with a ready-made diagnosis of appendicitis, exhibiting only pain in the right lower abdominal quadrant and tenderness on pressure over McBurney's point. All tests failed to confirm the clinical diagnosis of chronic appendicitis, but exploratory incision was made. A perfectly healthy appendix was removed. Three months afterward the patient was entirely well. In explanation Larson makes the statement that there was no evidence of a psychoneurotic element in his patient.

It may be true that no such evidence was found; but who shall say whether the neurosis existed without recognizable signs? And very likely the subsequent history beyond the three months' period might tell a different tale. Larson testifies that in making a diagnosis of chronic appendicitis most authorities agree that pain on deep pressure over McBurney's point is always present.

Mulligan emphasizes the importance of local tenderness and rigidity as characteristic of appendicitis, both acute and chronic, and points out the well-known fact that tenderness here as in any part of the body always coincides with the seat of the lesion.

He might have added that pain does not necessarily conform to this law, but is frequently found at a distance from the actual diseased area, transferred by reflex action.

According to D'Acierno, pain in the right iliac fossa, though found in the majority of cases, is not constant in chronic latent appendicitis, or appendicitis with referred symptoms. The subjective pain is not felt in the right lower abdomen, but in the epigastric region. Further he avers that the mere pain in the right lower quadrant, unaccompanied by the other chronopathological symptoms, is not sufficient evidence of existing appendicitis, and that any appendicectomy based exclusively upon this symptom, as a rule, will result in failure from the therapeutic point of view. This statement is in exact accord with the views of all experienced surgeons.

Special Examinations.—In some of the more doubtful cases examination calls for consideration of the eyes, tonsils, and sinuses, analysis of gastric contents, complete blood study, cystoscopic tests, investigation of the stools, and x-ray examination. I have seen the fitting of *proper glasses* cure persistent right iliac pain; repeatedly *tonsillectomy* clears up suspicious cases, with pronounced digestive disturbances, and frequently appendix and tonsils are joint offenders, removal of both being necessary; a number of appendicectomies have been done in patients with *chronic infections of the accessory sinuses of nose,* which remained to give the real trouble. Analysis of the *stomach contents* in chronic appendicitis cases will show a large percentage of hyperacidity, though some will give a low acid ratio and a few will present no acidity. *Blood examination* is of no great moment as a direct diagnostic factor although the leukocyte count may be always a little above the normal in a patient who has a chronically inflamed appendix.

A series of chronic appendicitis cases were studied by Dutton to determine the value of an increased mononuclear blood-count as a diagnostic aid. It was found that 47.5 per cent (or perhaps 55.9 per cent excluding possible physiologic appendicitis) of the cases actually have an increase in large mononuclears. This is at wide variance with Friedman's findings. To establish whether or not any lesion of the appendix was capable of increasing the mononuclears, a study of acute cases was done showing that only 15 per cent showed a mononuclear increase. Dutton concludes that in about 50 per cent of cases of chronic appendicitis an increased mononuclear count is a help in diagnosis, and that this increase is in all probability not due to the appendix being infected, but to the character of the infection (chronic). Since chronic salpingitis shows 30.5 per cent and chronic cholecystitis 47.5 per cent mononuclear increase, too much reliance should not be placed in obscure cases upon this interesting blood finding.

The *cystoscope* is needful to discover a kink of the ureter, the location of a calculus or the possible infection of a kidney. *Stool examination* has resulted in the finding of parasites, or of mucus and blood—the signs of a colitis which may or may not have its origin in chronic appendicitis.

Roentgen Ray in the Diagnosis of Chronic Appendicitis.—The x-ray examination indicated in many cases for the diagnosis of chronic appendicitis is of such importance as to deserve particular mention. Accumulated literature on this subject in the past few years has reached enormous proportions. By some writers the value of the roentgenological examination has been overestimated; by a few surgeons and an occasional gastro-enterologist it has been underestimated or ignored. Without doubt there is a place for radiologic study in the diagnosis of chronic appendicitis; but it must be done efficiently and conscientiously with the closest coöperation of surgeon and roentgenologist. At best the study can be only confirmatory; for the history, the symptoms and the physical examinations are our guides and, if the x-ray findings do not conform to the clinical signs, so much the worse for the x-ray. In fact the roentgenological investigation should be undertaken and accomplished in the light of the symptomatology and the roentgenologist should be regarded as a clinical consultant. One of the greatest assets of the x-ray examination is its usefulness in confirming or rejecting findings in other organs, easier to elicit than the direct determination of appendical lesions.

The method of procedure consists in the administration of an opaque meal, usually barium sulphate in a thick medium, such as buttermilk, followed by fluoroscopic views of portions of the digestive tube and a series of films taken at certain intervals. The points of significance are the stomach and the duodenum, the lower ileum and the cecum with the appendix. From the behavior of these divisions can be derived helpful knowledge leading to a diagnosis. The actual detail of the technic is in the hands of radiologic experts who employ their own particular methods.

The following technic has been followed in our clinical work, as conducted by Robert P. Noble, roentgenologist, and reported by him: "The stomach and the gall-bladder are examined routinely in every case sent for examination of the appendix. The usual barium meal is given for the stomach examination and another examination with a second meal five hours afterwards is also made. The patient is observed with the fluoroscope at each of these examinations in the standing and the dorsal positions, and the entire abdomen is palpated lightly and then heavily for tenderness. This palpation if done properly is of great value at the twenty-four hour examination, at which time the patient is prone. Before touching the abdomen a careful survey of the inside is made with the fluoroscope. Ileal stasis and kinks, leaking ileocecal valve and variations in the size and shape of the colon are conditions not to be overlooked, and their bearing in the case is carefully weighed. The appendix may be obliterated; it may be closed at the opening to such an extent that none of the barium will enter. It may be segmented or only filled at the tip. It may be long or short (Fig. 29), large or small; lying behind the cecum and extending upward (Fig. 30) or pointing downward (Fig. 31) and inward into the pelvis (Fig. 32), sharply bent, hooked or curled (Fig. 33). Oftentimes an enema is required to bring out defects which the barium meal does not. Proper palpation during a painstaking fluoroscopic examination should enable the roentgenologist to give an opinion worthy of consideration. Less careful examination probably accounts for many wrong diagnoses. Other abdominal pathology is to be ruled out and the roentgenologist should coöperate with the internist and the surgeon in reaching a final diagnosis. We consider the x-ray a great help in the diagnosis of chronic appendicitis."

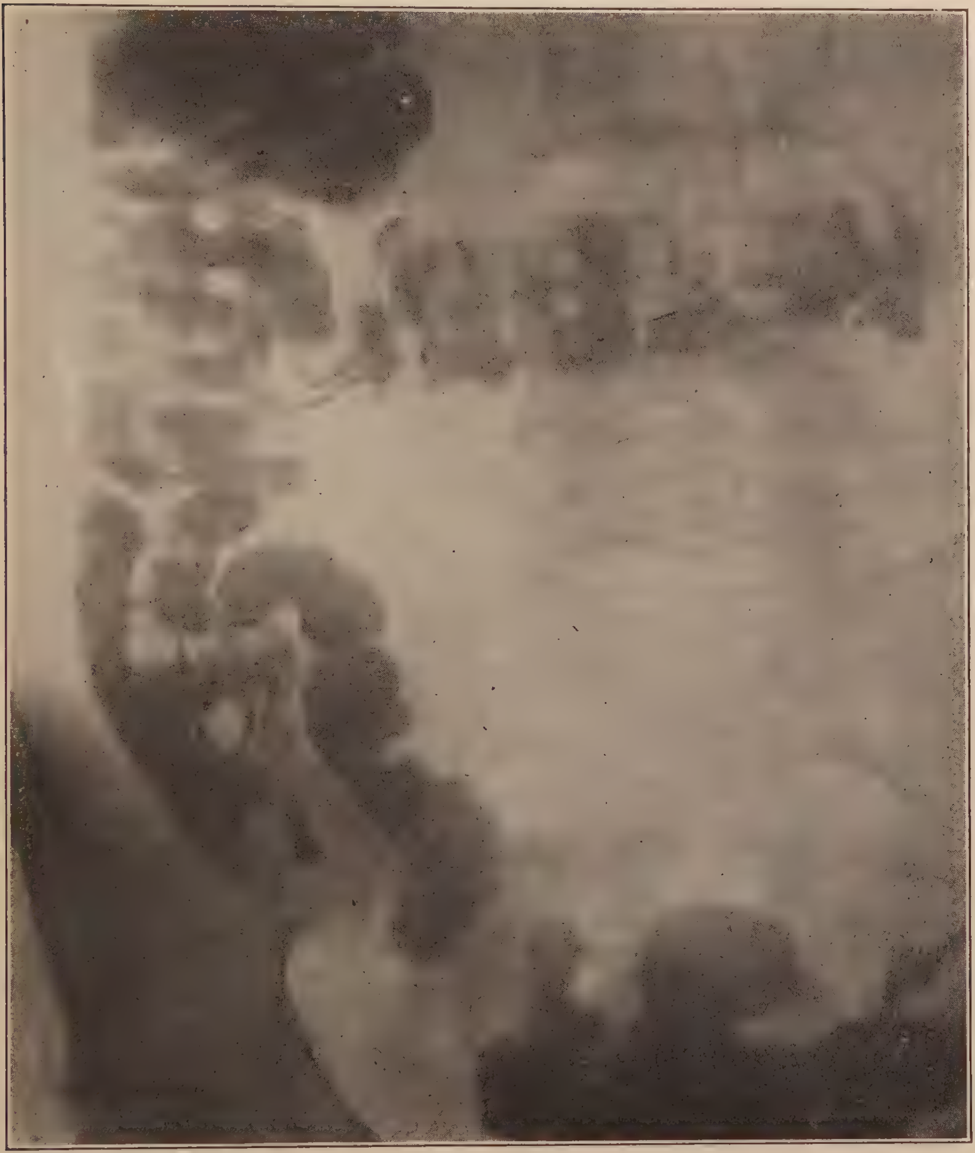

Fig. 29.—An Apparently Short Appendix, Barium Entering only One-fourth of Distance; Stricture and Adhesions. (Roentgenogram by R. P. Noble.)

Concerning the methods in vogue and the value of the x-ray diagnosis in chronic appendicitis, roentgenologists, internists and surgeons are by no means agreed. Although advised in most cases the radiographic examination presents questionable findings which must be taken together with all the phenomena for reaching a conclusion (Fig. 34). Its chief importance is to

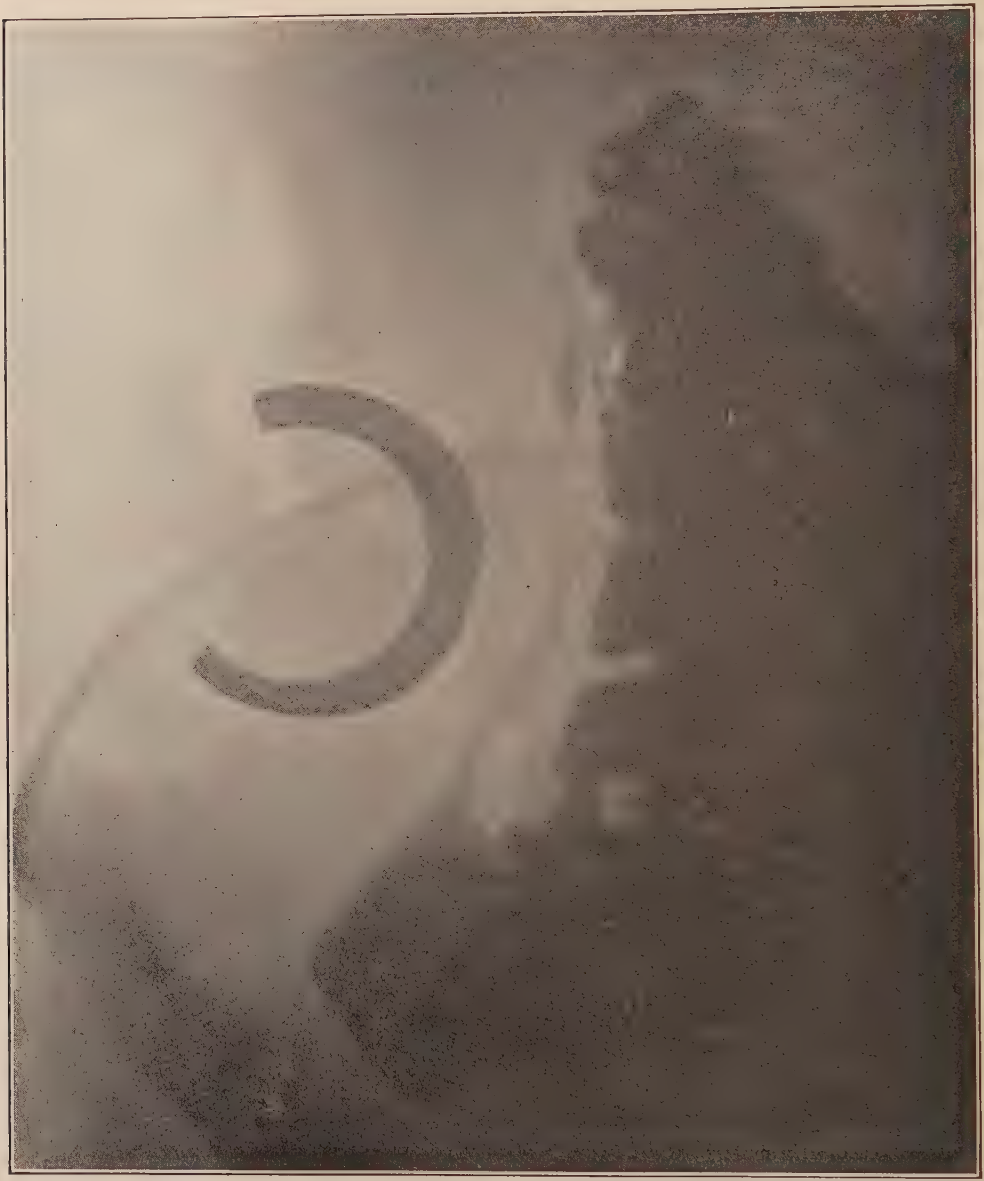

Fig. 30.—A Long Appendix Extending Upward, External to the Cecum.
(Roentgenogram by R. P. Noble.)

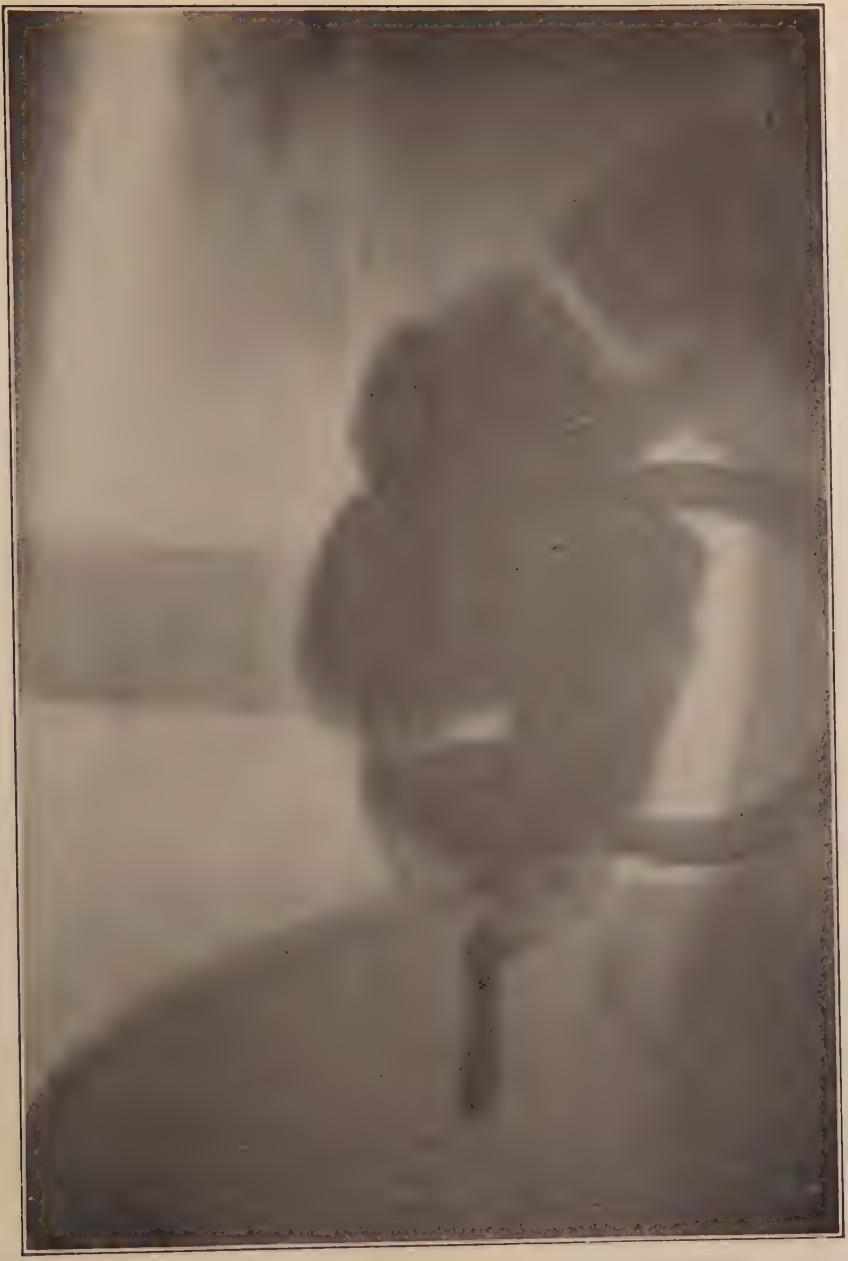

Fig. 31.—Subcecal Position of Appendix, Two-thirds Filled.
(Roentgenogram by R. P. Noble.)

clear up the diagnosis of lesions outside the appendix area, to avoid errors of omission and commission, to confirm the presence of complications.

Radiologists differ much in their opinions. Some years ago Bennett sounded a warning against drawing conclusions about intestinal lesions when

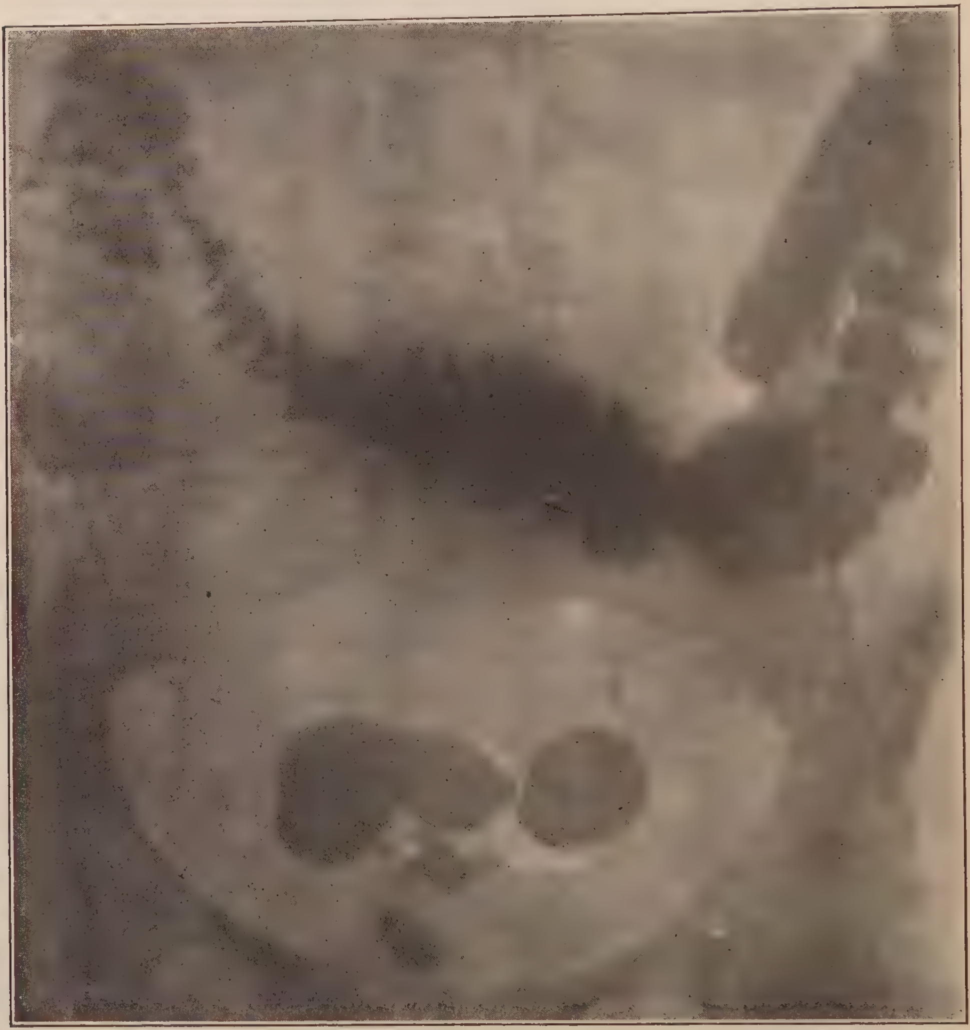

Fig. 32.—A Long Appendix, with Contracted Lumen, Hanging over Brim of Pelvis where it was Adherent. (Roentgenogram by R. P. Noble.)

examined under abnormal conditions, as in the large mass of barium in any part of the alimentary canal and the violence often expended upon the ileocecal region by palpation. He laid emphasis upon the fluoroscope and not the skiagraph; refuted the claims of certain writers that in 75 per cent of cases the appendix could be demonstrated by the opaque meal; believed that the visibility is not of great moment; considered the mechanical effect of a diseased appendix as of the chief importance, seen particularly in interference with the ileocecal valve, upsetting its delicate adjustment and causing either regurgitation from the cecum or spasmodic retention in the ileum.

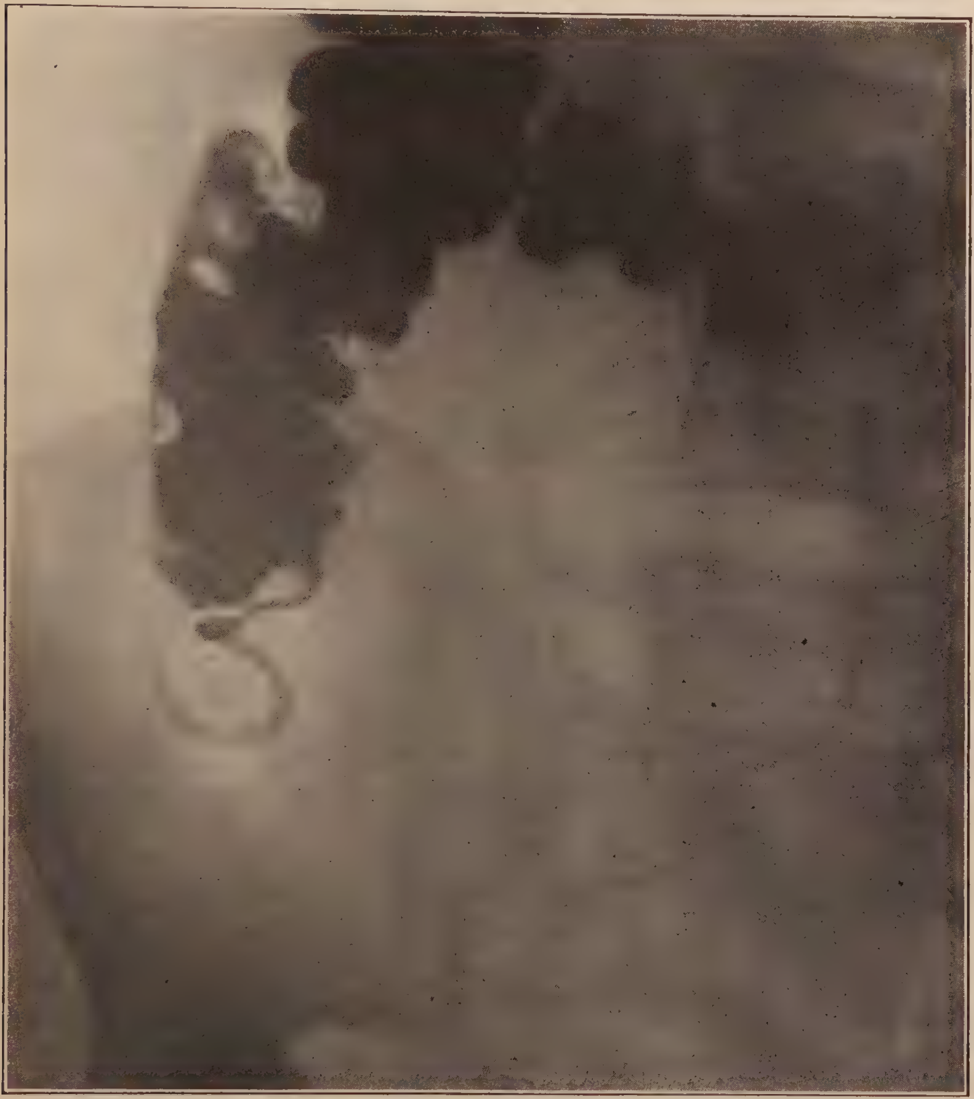

Fig. 33.—A Curled Appendix, "Corkscrew" Type. (Roentgenogram by R. P. Noble.)

According to Jaisson, Beclere, in 1909, presented a radiogram of the appendix to the Société de Radiologie. The following year, Aubourg, and Fayard, each contributed plates. In December, 1911, Belot made a communication to the Société de Radiologie on "the appendix seen by radioscopic examination." The same year, Desternes and Baudon made a report to the

Congress de Dijon on the same subject. The observations of Liertz, 1910, Reid, 1911, Griegorieff, 1911, can be cited. In 1913 Case recommended the suspension of barium sulphate in whey. He maintained that with this type of opaque meal, the appendix could be seen in seventy out of a hundred cases. In 1914 the same author published a series of 763 cases, 275 of which were positive. Next appeared the studies of Huret (1914), Case (1914), Imboden (1915), Carman and Miller (1915). In 1915 George and Leonard took up the study of the appendix according to Case's method. Up to the time of these last-mentioned authors a picture of the appendix had been obtained from time to time; but a methodical study had never been made. They showed that the fact of obtaining a picture of the appendix was not in itself

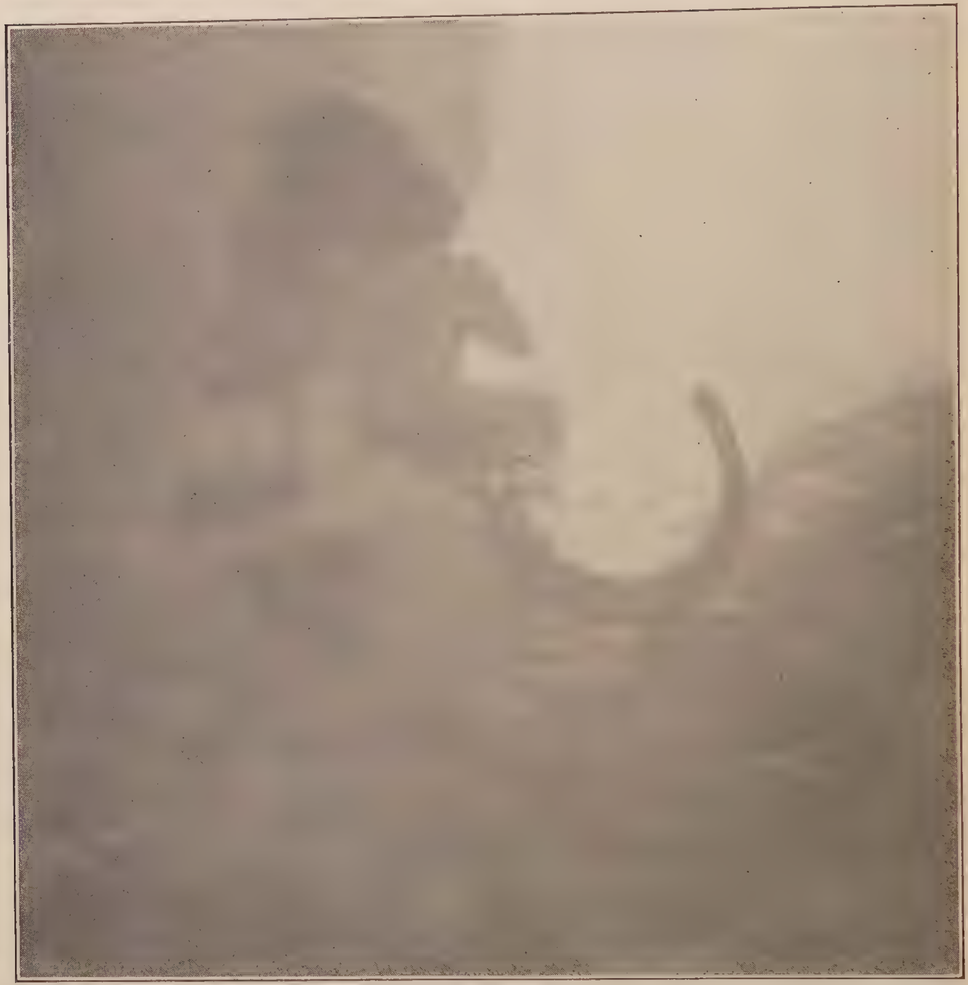

Fig. 34.—A "Question Mark" Appendix; Adherent High Up at the Hepatic Flexure; Nondescent of the Cecum. The appendix may be seen within the palpation ring in the shape of an interrogation point with its dot below it. (Roentgenogram by R. P. Noble.)

a pathologic sign. Nevertheless, they exaggerated somewhat, said Jaisson, when they claimed that in every case, whether healthy or diseased, the appendix is visible, if its lumen is free. He saw the appendix in eight out of ten cases, about his average. In a summary he found the radiologic diagnosis of chronic appendicitis to rest upon an ensemble of (*a*) physical signs: inequality of filling, angulations, fecal concretions, vacuoles; and of (*b*) functional signs: immobility, contractions, a point of pain, delay in evacuation. He did not expect radiographic examination to decide all difficulties; but believed its office is merely to complete the clinical picture in the same way as does the laboratory examination; and, particularly in cases of baffling symptomatology as in the child, or complex as in the woman, it will be a valuable help in doubtful cases.

A syndrome having four cardinal features, illustrating the radiographic appearance in cases of chronic appendicitis and some of its complications, was thus expressed by Ellis: (1) Delay in the progress of the opaque meal at the ileocecal region; (2) a Lane's kink; (3) a controlling pathological appendix; (4) the pulling down and kinking of the proximal portion of the transverse colon.

Eastmond's comprehensive paper classifies the evidence secured by the Roentgen ray as *direct* and *indirect:*

A. Under direct evidence he mentions: (1) Lack of homogeneity of the appendix lumen, in which a local area fails to show the full amount of barium, suggesting fecal concretions. (2) Irregularities of lumen, of two types, *i.e.*, the dilated tip (or "clubbed appendix") and contractures over larger or smaller areas. (3) Abnormal fixation in any part of the organ. (4) Tenderness, indicative of a pathologic appendix shown best by an unconscious tightening of the abdominal wall. (5) Abnormality of form, as in coiling, twisting, etc. (6) Retention of the appendical contents after emptying of the cecum—very important.

B. Indirect evidence of value in confirming the direct findings and also in those cases where the appendix cannot be visualized includes: (1) Adhesions of the terminal ileum, shown when the barium is seen both proximal and distal to the affected part with none between, not uncommonly observed in patients who have had typhoid fever. (2) Abnormal fixation of the cecum, suggestive of long-standing appendical inflammation, if malignant growths and tuberculosis of the cecum, kinks and bands, and insufficiency of the ileocecal valve can all be excluded.

No one has stated more clearly "the roentgenologic aspect of chronic appendicitis" than Pancoast, who discussed the matter under five heads. His views may be stated as follows: (1) Congenital anomalies in position, such as transposition of viscera and failure of complete rotation of the cecum, in both of which demonstration of the location of the appendix is of help to the operating surgeon. (2) Observation of the visualized appendix—not now regarded *per se* as evidence of disease, but important in relation to its emptying time, to pain on pressure, to the neighboring anatomical structures. (3)

Abnormalities in other organs suggesting appendicitis when the appendix is not visualized, chief of which is the presence of adhesions about the terminal ileum, especially if associated with definite pyloric spasm. (4) The finding of some other condition than chronic appendicitis to account for the symptoms, relating in order of importance to ureteral stones, gall-bladder disease, gastroduodenal ulcer, diverticulitis, malignancy and tuberculosis of the cecum and disease of the spine. (5) The discovery of some coexisting surgical condition of the abdomen such as those just mentioned, a complete study of which often justifies the surgeon in attending only to the appendix, if the extra lesions are not found, or directing him to the proper field when the complications are demonstrated.

The radiological evidence is thus summed up by Levyn: A visualized appendix tender upon fluoroscopic palpation; a nonvisualized appendix on account of obliteration of its lumen; constant kinking and strictures; concretions; adhesions; pylorospasm. He does not believe that an appendix which retains barium after the cecum has emptied is necessarily diseased. Ehrlich concluded that it is chronic appendicitis he is dealing with if the ascending colon is not empty six hours after the contrast test meal. He has the patient, however, take an ordinary meal one and a half hours after the test meal.

The proposal of Ehrlich is rejected by Weinstein, who holds that this method makes it difficult to determine the emptying of the stomach, and prefers the old technic of examination after four hours without additional food, since the residue in the ileum presents nothing of value when the emptying of the stomach is delayed.

Mongeolle advised that the fluoroscope examination should be made first after six hours and last twenty-four hours following the opaque meal, with many observations between times. He found the appendix visible in 85 per cent of cases and that it did not empty until at least twelve hours after the cecum; he considers the functional findings the most important and the localization of the pain under the screen as the keynote to the radiological diagnosis of chronic appendicitis.

In the opinion of Cushway and Maier, a definite relation exists between the symptomatology and the radiological findings in chronic appendicitis, even to the extent of predicting the findings in 90 per cent of the cases when certain symptoms are present. Their estimations are based upon the following signs with their corresponding x-ray conditions: Dysphagia and substernal distress mean cardiospasm; regurgitant vomiting and gaseous eructation indicate spasm of the cap and atonic stasis of the stomach; malaise, anorexia and loss of weight show colonic stasis and spasm of the ileocecal valve; epigastric pain and tenderness with hyperacidity exhibit hyperperistalsis and pylorospasm. Direct evidence of chronic appendicitis consists of tenderness, delayed emptying and fecal concretions in the appendix.

Indirect signs are helpful, says Feldman, especially when the appendix is not visualized; but these should always be corroborated clinically. Insufficient Roentgen signs and faulty interpretation are misleading, whilst conservative interpretation is of great value. Roentgen examination does not always eliminate the presence of chronic appendicitis and again divers Roentgen signs may be observed without clinical manifestations. The presence of chronic appendicitis as noted by Roentgen examination does not by any means always indicate the necessity for surgical intervention.

White considers most of the x-ray signs, both direct and indirect, of little significance. In his experience "beading" in the appendix occurs in about one-third of normal cases, and so is of no value as denoting pathological conditions, except when it shows failure to empty well; fixation is important if it applies to the middle or tip of the appendix and adhesions are shown by changes in contour of the cecum; curling, kinking, occlusion or narrowing are suggestive, if constant; ileostasis is of slight value, pylorospasm is not distinctive, incompetence of the ileocecal valve is often found when the appendix is not diseased. The normal appendix, according to White, empties in one or two days, but may remain filled a day or two longer, if it fails to drain properly. He thinks that the clinical history always should be considered by the roentgenologist.

Deductions from x-ray examinations made by Childs have warranted the following conclusions with comments, arranged in what he considers the order of their reliability: (1) A visualized appendix constantly tender to palpation. This is considered one of the most reliable signs, but tenderness in the right iliac fossa, unless so limited, can be caused by several other conditions and should not be assumed to indicate a pathological appendix. (2) A persistent kink or angulation in the appendix. This is also a reliable sign of pathology and is generally due to an adhesion at the point of angulation, or to a short mesentery. (3) Delayed emptying of the appendix. A visualized appendix after the cecum and ascending colon are empty denotes faulty drainage and forms an important link in the chain of pathology. (4) A bulbous tip with small lumen near the cecum. This condition is ideal for a poor drainage system and in this type slow emptying occurs in the majority of cases. (5) Fixation of the appendix by adhesions throughout its entire length or at its tip only. This is not considered *per se* sufficient evidence for its removal. (6) The presence of concretions. Considered contributory evidence of pathology. (7) A segmented appendix. Not considered reliable unless associated with some of the other signs above mentioned.

Childs further states that in his experience the appendix is visualized in over 70 per cent of cases in which barium is taken by the mouth; that some of the nonvisualized appendices are postcecal; that an x-ray diagnosis of chronic appendicitis without a visualized appendix is unreliable and unwarranted. Quoting Bettman on the one hand, to the effect that "the roentgenologist, as his very greatest contribution to the diagnosis, can merely make anatomic observations and describe them," and Lahey, on the other hand, who says, "Expertly applied, wisely interpreted and properly correlated, no one can question its (roentgenology) inestimable value," Childs begs the roentgenologist to realize that his true position is that of a consultant and that he must equip himself for this dignified position.

Gray believes that by improved technic and frequent observations more appendices will be visualized. He includes under direct evidence: Abnormalities in the contour of the appendical lumen, local dilatations and constant constrictions; retention of barium longer than twenty-four hours after the cecum has emptied; pathologic fixation or kinking; the presence of fecaliths; tenderness on pressure that remains invariably over the appendix, regardless of a change in the position of the patient. Under indirect evidence Gray mentions pyloric spasm, ileal stasis and spasticity.

A late personal communication from the Mayo Clinic through E. Starr Judd, stating the position of the x-ray section upon the roentgenologic diagnosis of chronic appendicitis, is expressed as follows: "We attach no importance to the x-ray examination of the appendix; our experience was such that we felt it was without value." Judd adds that this could be given as the general opinion of the Clinic.

The diagnosis of chronic appendicitis by the x-ray makes no appeal to Deaver.

Carson says: "X-ray examination as a means of diagnosing appendicitis has little value."

Dubois-Trepagne realizes the uncertainty of x-ray diagnosis in appendicitis. He states that there are only two signs that have an unquestionable value: When a roentgenogram with a representation of the appendix in the immediate vicinity of the contrast medium is secured, or when the shadow of the vermix persists after forty-eight hours.

In a timely contribution Orndoff emphasizes the necessity of roentgenologic observations conducted while the patient is being rotated from the perpendicular to the oblique planes, along with skillful palpation in the presence of opaque or solid media, or both. He regards the appendix with central constriction of the lumen as one that most frequently becomes inflammatory.

Comment.—This rather extensive discussion of the x-ray as a diagnostic agent in chronic appendicitis is given here as a sort of chronological review as well as a fair presentation of the different opinions and practices during the past few years. The views are greatly at variance. From them, however, we can gather that the radiologic investigation may be helpful in certain instances, but that it can in no wise be regarded as a universal and dependable method and that of itself it means little. One of its chief points of value is the definite location of the ileocecal angle and the appendix, an aid in the placing of the incision and the conduct of the operation. A left-sided appendix can be located with certainty only by this means.

I am in agreement with those who are inclined to discount the importance of the direct x-ray findings in chronic appendicitis, but who still lay great stress upon radiological study to rule out lesions of other parts, which may exist instead of, or in addition to, the diseased appendix. As a means of elimination the fluoroscope is valuable. The hopeless state of the barium picture is that on either horn of the dilemma, the diagnosis is usually confirmed: If the appendix fills and the emptying is delayed, it is diseased; if it does not show at all, it is considered pathological; if it visualizes partly, or in segments, it is inflamed. We are caught coming and going.

Just as heartily do I find myself on the side of those who believe that the roentgenologist should be a true consultant, competent to bring out and understand the clinical signs; that he must work in conjunction with the physician and the surgeon. There should be no absolution in this method of diagnosis. No one phenomenon can be depended on. Taken with all the other evidence the x-ray signs may be of great interest. My feeling leans more and more to the skeptics, who are depending less and still less upon direct radiological results in the diagnosis of chronic appendicitis. At the same time in an obscure case I would not hesitate to advise roentgenological study, or any other method which might possibly help in the diagnosis.

"Signs" in Appendicitis.—For many years a number of "signs," named after the observers who announced them, have been more or less in general use for the diagnosis of appendicitis. By some these "signs" are looked upon as pathognomonic, and in certain respects a few of them are reliable; but, on account of the double personal equation of doctor and patient and the inconstant character of the pathology, none of them is infallible. Almost exclusively the "signs" are useful in chronic appendicitis, where the diagnosis is more obscure and the study of the reflexes is more essential. They are still placed in the class of eponyms and by the names of their authors, alphabetically arranged, they will be designated here.

Aaron's Sign.—A feeling of pain or distress in the epigastrium, umbilical region or left hypochondrium is produced by continuous firm pressure with the tips of the first three fingers over McBurney's point; also during this pressure pyloric spasm may be observed under the fluoroscope.

Bastedo's Sign.—There are pain and tenderness in the right iliac region upon inflation of the colon with air, introduced through an ordinary rectal tube by means of a pump such as is used with the sigmoidoscope.

Blumberg's Sign.—Blumberg's sign is characteristic of active peritonitis. Sharp pains are elicited by sudden removal of the hand from the abdomen after pressure has been made. After subsidence of the inflammation the pressure pain exceeds that made by the sudden relief.

Cope's Sign.—Pain and resistance on internal rotation of the thigh, due to stretching of the obturator internus, are referred to by the author on the ground that "inflammation of the peritoneum over the external iliac vessels causes pain in the hypogastric region when pulsation in the femoral artery is stopped by pressure in the thigh."

Gray's Sign.—"If one presses with the point of the finger somewhere about 1½ inches below and to the left of the umbilicus one can frequently elicit tenderness there. Occasionally, at the tender spot, there seems to be a small aperture in the rectus sheath. It is possible that this tender spot corresponds to the point of emergence of the terminal branch of the eleventh dorsal nerve. The amount of pressure required to produce the feeling of tenderness is estimated. The pressure is relaxed and then with the back of the hand diffuse pressure is made and sustained over the appendix region, which is usually also tender. Then the same amount of pressure is exerted at the same spot as before on the left side, with the point of the finger of the other hand. If the sign is positive the tenderness there is not now appreciated by the patient or is lessened considerably in degree. This sign, when positive, is evidence of the presence of either a submesenteric appendix or a Lane's terminal ileal membrane. If the presence of a retrocecal or retrocolic appendix has been already established, then the sign indicates a Lane's membrane only" (Gray). He considers this a reliable palpatory test, but had not formulated any fitting explanation of the phenomenon.

Gregory's Sign.—Percussion of the left half of the abdomen, especially at a point midway between the umbilicus and the anterior superior spine of the ilium, corresponding with McBurney's point on the right, produces a concussion which travels along the small intestine, is transmitted to the diseased appendix and manifests itself by pain at McBurney's point, as well as in other regions, if the appendix lies out of its usual position. Percussion made more laterally over the descending colon, according to this observer, lessens the conductivity of concussion to the diseased appendix, while percussion nearer the median line elicits no sensation at all owing to contraction of the rectus muscle. (This phenomenon would seem to be but a modification of the Rovsing sign, to be noted below; but Gregory says he has obtained it in all his cases of appendicitis, even when the Rovsing sign was absent.)

Horn's Sign.—Traction on the spermatic cord causes severe pain in the right iliac region.

Iliescu's Sign.—Pain from gentle pressure on the right phrenic nerve in the neck is positive in 150 acute or latent cases, negative in right adnexitis, disappearing under ice applied over the appendix and reappearing with an exacerbation; ascribed to an ascending right lymphangitis, irritating the phrenic nerve.

Meltzer's Sign.—Marked tenderness is produced when, with the patient lying flat on his back, arms elevated and knees partly flexed, pressure is made over McBurney's point, while the right leg is extended; the extended right leg is kept rigid and gradually elevated, thus impinging the appendix between the abdominal wall and the belly of the psoas muscle.

Ott's Sign.—When the patient is on his left side, there is a feeling of distress and of a painful dragging sensation as if a heavy body in the abdomen had fallen to the left; sometimes referred to as the "mesenteric pull."

Rovsing's Sign.—Pain at McBurney's point is induced by pressure exerted over the descending colon; the original type of phenomena elicited by reflex action originating at a distance and proceeding directly to the appendix.

Sorcsi's Sign.—With a patient in the dorsal position and the thighs flexed, the examiner's hand is pressed gently on the hepatic flexure under the rib margin; the patient is directed to cough and asked if there is pain; on an affirmative response and inquiry as to the location of the pain, he will indicate McBurney's point if a genuine appendicitis is present. A particular warning is given not to palpate around the McBurney area. Soresi says it is the pressure of gas in the colon forced downward upon the diseased appendix that gives rise to the pain, and that two distinct elements enter in, *viz.*, contraction of the right rectus muscle bearing down on the appendix, and the psychic reaction of the patient, causing him to tell the truth when his attention is drawn away from the appendix. (The same suggestion must be made here, as in the case of Gregory's sign; Soresi's observation, while undoubtedly helpful, represents a refinement of Rovsing's sign, previously described.)

Wachenheim's (or Reder's) Sign.—Sharp pain is felt over the ileocecal area on rectal palpation with finger tip directed upward and to the right; examination to be performed gently and slowly; a rarely elicited sign, not to be confused with rectal exploration to determine the presence of an appendical mass.

Wolkowitsch's Sign.—There is abnormal relaxation of the abdominal wall, especially the right; the muscles are shrunken and less elastic, shown by the tonometer; characteristic of chronic appendicitis in marked contrast to the acute form.

Comment.—Although, as previously stated, these signs are not universally dependable and are often difficult of interpretation, yet they may be very helpful in diagnosis. They are not uniformly trustworthy and in many cases are not obtainable. Aaron's sign in my experience has stood the test of time, and is generally constant, especially in the way of reproducing the existence and location of the pain from which the patient originally suffered; Bastedo's is troublesome to bring out and is not popular; Blumberg's is a stand-by in proving the presence of peritonitis; Cope's is sane, but is found only in a small number of cases; Gray's seems to require unusual perception on the part both of physician and patient; Gregory's, Rovsing's and Soresi's depend upon the same mechanism and are suggestive, when present; Horn's is an unusual phenomenon, difficult of differentiation; Iliescu's, Wachenheim's (Reder's), Wolkowitsch's present interesting features, but are associated too largely with the personal equation; Ott's is a valuable observation; Meltzer's is a sound suggestion and, when properly evoked, is seen in 60 per cent of chronic cases.

Various writers have expressed themselves upon the value of these signs. Many commend them; just as many, perhaps, regard them negatively. The chief criticism is concerning their uncertainty. No case could be safely diagnosed upon one of these "signs" alone, or even all of them together. One finds them, however, of much interest in the examination and of very great assistance in the diagnosis of chronic appendicitis.

Analyzing one hundred cases submitted to the insufflation test (Bastedo's) in which chronic appendicitis was known or suspected (known in sixty-two cases), Jerlor notes that the negative cases did not go through an appendicitis course and the positive ones showed a negative response after appendicectomy.

Further, a positive reaction never occurred in the absence of appendicitis; but findings were negative in 46 per cent of the chronic cases, in 10 per cent of those with acute exacerbations, and in 7 per cent of the ulcerative and gangrenous type; in the three cases of peritonitis the response was positive.

Very soon after Rovsing announced his "sign," Hoffman, Lauenstein and others failed to confirm his conclusions based on over a hundred cases. Deaver has not found it of value.

Supplementary to the "sign" described by Iliescu is left shoulder pain in chronic appendicitis. Three cases are reported by J. Gray in which pain in the left shoulder was associated with chronic appendicitis, acting reflexly through the phrenic nerve and disappearing after appendicectomy.

Diagnostic Postures.—Drosin drew attention to the fact that the usual postures in examination by the usual method for diagnostic signs in appendicitis do not always elicit pain. New combinations of posture and pressure methods successfully elicit pain where any trace of inflammation or adhesions remain. He mentioned four postures in which it is possible to bring out the location of pain, if combined with a special method of eliciting the pain: (1) With the patient lying on the back, the knees either flexed or extended (both postures should be tried), two or three fingers of the examining hand are placed on the abdomen or near it, to the right of a line midway between the umbilicus and the ensiform cartilage. At the end of an expiration give a sudden push backward. In very acute cases this push should be moderate. The pain elicited will be mild, even if the case is acute. Usually no pain is felt but a shock described as a twist or other mechanical effect. This is especially symptomatic of adhesions. (2) The second position is the Sims', with the patient lying on his right side. This posture brings the cecum and appendix upward and forward into the palpating hand, the tips and palmar surface of which are employed for pressure. (3) In the third position the patient lies on the back with the right leg supported under the knee (left extended), which also brings the cecum and appendix upward and forward and tenderness or rigidity may be made out, if present. (4) In the fourth method, during a reflexed state of the abdominal wall between expiration and inspiration, bimanual pressure over both sides of the abdomen will give diagnostic information.

In retrocecal appendicitis Tresidder finds that lying flat on the face and abdomen allows the cecum to fall away from the inflamed appendix and gives relief from pain.

Also Przewalsky considers as a valuable sign in young persons a flat swelling above Poupart's ligament, composed of lymph glands and cellular tissue around the right circumflex artery. The right iliac muscle, he finds, is always flatter than the left, from atrophy on account of the inflammatory process affecting the branches of the crural nerve. This impairs function. Healthy persons can hold up the leg outstretched for two minutes; in cases with the above sign it is less by fifteen seconds. To test this the patient reclines, places the heel of the straightened leg in the examiner's hand a few inches above the bed, then endeavors to hold it up without support.

Differential Diagnosis.—The clear differentiation of chronic appendicitis from all the other conditions which can simulate or accompany the disease may tax the patience, skill and diagnostic ability of the most experienced clinician. In many instances, indeed, it is impossible to make the distinction. In such circumstances one should proceed with whatever treatment, medical or surgical, seems demanded, remembering the close pathological association between the diseased appendix and the other organs, the infections of which give rise to similar symptoms. Attention to one may allow attention to all. When it is out of the question to separate the affections which are in doubt, a strong suspicion of chronic appendicitis should lead to surgical investigation with an open abdomen for attending to every lesion present—but only after careful examination and adequate preliminary treatment has failed to bring improvement.

The very same conditions in acute form likely to be confused with acute appendicitis, and already considered in detail, are to be differentiated in their chronic forms from chronic appendicitis. The most important of these, with their special points of distinction, are:

1. *Gastric and Duodenal Ulcer.*—Here the history is exceedingly valuable—that of remittent spells of indigestion, associated with hunger pain, relieved by soft food and alkalies. Examination notes tenderness at the epigastrium, and hyperacidity of the gastric contents which along with the feces may contain evident or occult blood. The radiologic investigation usually gives definite results, demonstrating the ulcers in 85 to 90 per cent of the cases.

Chronic appendicitis may show all of these symptoms. The x-ray findings must be positive in order to rule out ulcer. And, even then, both types of ulcer may coëxist with chronic appendicitis. Surprises will turn up. Many cases with every sign of upper abdominal ulcer will show only a thickened, adherent appendix, containing perhaps a fecal concretion; while a definite syndrome of chronic appendicitis may have an ulcer for its cause. Pertinent to this question is Sir Berkeley Moynihan's illuminating remark: "There now is no longer any doubt in my own mind that *the commonest site of a gastric ulcer is in the right iliac fossa.* That is to say, that in the majority of cases, in which the most erudite teaching . . . would justify or compel a diagnosis of ulcer, the patient is suffering from a lesion elsewhere and, more often than not, from a lesion in the appendix" (*Address in Surgery, Brit. Med. Assn.,* 1913).

Both gastric and duodenal ulcers are looked upon as secondary metastatic lesions and the appendix is thought to be a frequent source—as high as 80 per cent by some observers. They may result from a common focus. Flint, of Leeds, is authority for the estimate "that a clinical diagnosis of gastric ulcer is wrong in nearly two cases out of three"; and "that 60 per cent of gastric disturbances owe their origin to a source outside the stomach." Heyd likewise believes that "40 per cent of the indigestions are due to causes extrinsic to the stomach but within the abdomen, and 40 per cent are due to causes entirely remote from the stomach." He enumerates the extra-abdominal conditions giving rise to "indigestion" in the following order of frequency: heart disease, phthisis, anemia and chlorosis, neuroses or psychoneuroses, chronic nephritis.

The reverse side of the coin is represented in an instructive instance reported by Bassler. He attended a stockbroker aged fifty, who a year before suffered during the night intense abdominal pain, with vomiting and a temperature of 104° F. A week later burning sensations in the chest and pain continued, always induced by exertion; at times he could hardly walk five or six blocks without an attack, when he would fall to the ground, crying with agonizing pain down the left arm. Three physicians diagnosticated angina pectoris. On examination: Slight gastric hyperacidity, indicanuria, occult blood and excess of mucus in stools; heart and vessels normal; blood-pressure, systolic 105, diastolic 93; radiogram shows moderate ptosis, an abnormal appendix sensitive to pressure. Operation was performed. A chronically inflamed appendix with subacute exacerbation was found and removed. For three months afterward there was mild pain and burning in the chest; one year later the patient was absolutely well—skating, swimming and taking long walks with no return of the attacks.

The question naturally arises, was the so-called angina due to toxic causes? Also it might be pertinent to inquire his later history, since one year's relief might have been a remission.

Heyd makes a point of differentiation in that the symptoms produced by ulcer exist over a longer period than a few hours, as seen in chronic appendicitis, and the interval of relief is of short duration.

Yet we know that ulcer symptoms may be present constantly for several months, only to undergo a remission for a longer period before they recur; and certainly the "stomach trouble" due to chronic appendicitis may represent a continuous though irregular period of suffering over a considerable time.

Beckman refers to a report by Blackford who in an analysis of a thousand cases that presented themselves for stomach troubles found the following results: 141 gastric; 345 abdominal reflex, principally gall-bladder or appendix; 181 systemic, *viz.*, renal, cardiac, tuberculous, pernicious anemia, etc.; 151 functional, or neurotic.

2. *Chronic Cholecystitis or Cholelithiasis.*—Here there is persistent disturbance of the stomach, accompanied at intervals by mild or severe pain at the epigastrium, extending to the right scapula; generally there is vomiting, and jaundice may appear; in prolonged and more serious cases there may be acute exacerbations with fever, chills and sweats. In cases with the latter type of symptoms stones in the ducts or gangrene of the gall-bladder are to be suspected. The history is that of recurring upper abdominal attacks, consisting of pain, gas excess, and "indigestion," with a possible typhoid fever in the background. Physical examination will bring out tenderness just

below the tip of the ninth costal cartilage, especially by deep thumb pressure upon inspiration immediately following complete expiration and accentuated by the Murphy "hammer stroke" percussion. Also there may be the Boas sign, *i.e.*, a tender spot in the twelfth interspace posteriorly 2½ inches to the right of the spinal column, which its author proposed as pathognomonic of gall-bladder disease, but which can be placed only in the helpful class. Its elicitation should not be obtained by suggestion or leading inquiry, but by first finding the tender area and then noting its position. Radiographic information of the gall-bladder is not very dependable. Even when stones are present it is only in a small percentage of cases that they cast a shadow—and, of course, in a large number of instances they are absent. Nevertheless, some knowledge may be derived from the fluoroscope and the x-ray pictures, and this method is not to be excluded.

The recent use of cholecystography introduced by Graham and Cole, a means of rendering the gall-bladder visible by injecting into the blood stream certain solutions which are opaque to the Roentgen ray, has promised much in the diagnosis of cholecystitis and its allied conditions. At first before the technic had been perfected, the method was unreliable in its results and not entirely free from danger. Under improved conditions the method has proved safer and more valuable. In their latest report Graham and Cole (St. Louis) present their newest substance—a solution of the sodium salt of phenoltetraiodophthalein, which they believe possesses decided advantages over anything else hitherto employed, giving a diagnostic accuracy of 97 per cent. McCoy and Graham (Cleveland) record their findings from the use of the same solution under the following summary: In twenty-six consecutive cases submitted to operation the diagnoses made by cholecystography were confirmed in 96 per cent; in 212 cases collected from literature the cholecystographic diagnoses were confirmed in 91 per cent when the dye was administered intravenously and in more than 80 per cent when given by the mouth.

Comment.—The major triad of the abdomen—cholelithiasis, gastric or duodenal ulcer, and appendicitis—are with difficulty differentiated. In a very particular sense is this difficulty manifest in the chronic forms of these affections. It may be impossible and actually unnecessary to work out the detailed refinements of diagnosis. The essential factor to establish is that a lesion exists and to determine its treatment upon the soundest judgment. The pathology of these important structures is closely allied, and disease in one may depend upon disease in the others, or, indeed, disease in all may be coexistent. In general, differentiation may be made by the diagnostic signs given in each affection. Even with the utmost care an incorrect diagnosis now and then will occur. How necessary it is then that all of these three conditions should be considered together, distinguished in diagnosis, if possible, and looked for at operation in every case. It has been assumed that they are often seen associated.

My impression is rather to agree with the skeptic view of Schütz, who felt that the common occurrence of a combination of appendicitis, ulcer of the duodenum and cholecystolithiasis (cholecystitis) has not been demonstrated with certainty; that the frequent association of duodenal ulcer following appendicitis may be because symptoms of the ulcer were wrongly diagnosed as appendicitis; that the same genetic relation applies to cholelithiasis and appendicitis. On the other hand Zweig (quoted by Andrus) reported thirteen typical cases of appendicitis confirmed by operation, in which duodenal ulcer and cholecystitis were also present.

3. *Nephrolithiasis.*—Between exacerbations a stone in the right kidney or ureter gives rise to vague pains in the right half of the body. Without care chronic appendicitis might be incorrectly diagnosed. The pain will be found invariably to originate in the right lumbar region and any tenderness present will be felt in the angle formed by the last rib and the erector spinæ muscle. A roentgenogram will settle the question. When the two affections occur together, each must be judged upon its merits. In appendicitis digestive disturbances are the common rule, while they are usually absent in kidney stone. Not all cases of renal and ureteral calculus, however, are free from abdominal signs. According to Andrus, Cecil in three hundred cases observed that 28 per cent had no lumbar pain and in six cases it was limited to the right lower abdomen.

4. *Floating Kidney.*—Floating kidney can be palpated bimanually. The history of acute attacks (Dietl's crises), already referred to, are relieved by lying down. It must not be forgotten that a nephroptosis may complicate, or, as believed by some, actually predispose to, chronic appendicitis. Along with a movable kidney is likely to be found a general visceroptosis or, at least, a gastro-enteroptosis, seen chiefly in women who also exhibit sloping shoulders, a long narrow costal angle, flat chest and protruding abdomen.

5. *Chronic Pancreatitis.*—Chronic pancreatitis presents epigastric pain, but in addition there are anemia, a yellow skin and marked loss of flesh; further the laboratory reveals sugar in the urine, a diarrhea with undigested muscle tissue, fatty particles and starch granules in the feces.

6. *Diseases of the Colon.*—Confusion may arise in distinguishing certain affections of the large bowel from chronic appendicitis. Simple or specific colitis, diverticulitis, tuberculous or malignant disease are to be eliminated. A chronic diarrhea, alternating with constipation, characterized by mucous stools, denotes a simple colitis. If the mucus is accompanied by blood or pus, showing ulcerative processes, careful examination of the stools for specific bacteria or parasites should be made and any masses of tissue coming away must be submitted for microscopic study. Tuberculosis, syphilis and cancer are to be held in mind. Diverticula most frequently are encountered in the sigmoid colon and unless they are inflamed do not give rise to acute symptoms. The x-ray is valuable in the diagnosis of these affections from chronic appendicitis, for by its use their presence can be confirmed or eliminated. In chronic colitis the bowels may be found narrowed with obliteration of its sacculations; while the existence of diverticula is easily determined. A chronically inflamed appendix may be the focus of irritation or infection,

from which colitis arises, and removal of the appendix has often put a stop to the whole affair. What was said of malignant disease of the colon in the section on acute appendicitis applies with equal force to the present discussion. For a greater reason one might fail to suspect cancer of the bowel when considering possible cases of the chronic type of appendicitis, on account of the vague and irregular signs, perhaps of long duration, preceding any acute manifestations. The age incidence is very important. Long ago Krecke enumerated the following data which should aid in the diagnosis of chronic appendicitis from other affections such as *chronic colitis:* The pain in appendicitis, as a rule, is boring or lancinating, while in colitis there is simply a sense of pressure or discomfort. In the former affection it is naturally restricted to a single area, and further tends to appear in successive crises. Dependence of pain to some extent on outside influences (exercise, menstruation) speaks for colitis, as nothing without either aggravates or mitigates the pain of appendicitis. If a sensitive point like the McBurney symptom is felt at some other region of the abdomen, for example over the sigmoid, it is probably of colonic origin. McBurney's point may be quite insensitive in chronic appendicitis. If a cordlike or cushionlike resistance is encountered over the ileocecal valve it doubtless proceeds from the colon. Altered stools —constipation, fermentation, admixture of mucus—are very suggestive of colitis but do not exclude appendicitis. Improvement under physical and dietetic procedure speaks against appendicitis as due to nervous disorders. The author in this comparison is influenced largely by the reproach brought against surgery on account of alleged "revenue" operations performed in which the appendix is found to be normal.

"Adhesions about the Ascending Colon Simulating Chronic Appendicitis" forms the title of a paper by Davison and Royer, who describe the constant finding of bands across the large bowel, giving symptoms of appendicitis, but often appearing after the appendix has been removed. The authors regard the condition as an inflammatory lesion due to colonic stasis, believe it to be a definite surgical entity and state that an absolute diagnosis can be made from x-ray examinations and in no other way.

Brule sounds a note of warning against regarding all gastro-intestinal disturbances with pains in the appendix region as appendicitis. He believes that the appendix plays a secondary part here and appendicectomy gives no relief. Appropriate diet and prolonged medical treatment, he thinks, are in order, confessing that differentiation of this "gastro-intestinal disturbance" from "true appendicitis is difficult."

One might make bold to inquire, what is "prolonged medical treatment"?

Irritation and malfunction of the colon, according to Jordan, frequently simulate both gall-bladder disease and chronic appendicitis, being differentiated by a comparison of the signs. In "irritable colon" the pain does not become definitely localized in a single area of maximum intensity; tenderness characteristically is present over the whole colon, which may be spastic and rolled under the fingers; vomiting does not occur with uncomplicated colon pathology, but occasional nausea, and constant dizziness and gaseous eructations; the barium enema fills the colon with greater smoothness and speed than normally; relief is experienced generally by the external application of heat, drinking hot water and by the expulsion of gas or feces. Jordan looks upon this condition as entirely medical in its management, but believes that in doubt it is wiser to perform a surgical exploration.

Freeman has described what he terms "the neurotic or irritable abdomen," which is often associated with a chronic obliterating appendicitis, and characterized by such symptoms as: pyloric spasm, hyperacidity, colicky pains, flatulence, biliousness, spastic and hypersensitive abdominal walls, and general nervous instability. The explanation may be found, says Freeman, in the pressure of contracting tissue upon the pathologically altered nerves in the obliterated appendices, just as occurs in sensitive scars and amputation stumps.

7. *Tuberculous Peritonitis.*—Tuberculous peritonitis in its mild chronic phases may be mistaken for chronic appendicitis. The ascitic form is easy enough to distinguish; in the cases without peritoneal effusion difficulty may be encountered. It is well to be on guard for *pulmonary tuberculosis,* a frequent accompaniment, and one which furnishes many errors of diagnosis of itself, independent of peritoneal involvement. Over and over the appendix has been removed only to find later that the suspected symptoms of chronic appendicitis were due to tuberculosis of the lungs, not previously investigated.

On the other hand chronic appendicitis may simulate pulmonary tuberculosis. Torres gives an example. In his practice a young woman for years had attacks of coughing, bloody sputum, congestion of the lungs, vomiting, and abdominal pain extending down the legs. Later she had kidney colic. The renal calculus which was finally expelled was said by Torres to result from forced feeding in treating an assumed tuberculous process at the apex at the lung, which was diagnosed upon x-ray evidence alone. No tubercle bacilli were found in the sputum. Symptoms pointing to appendicitis came with the next attack; appendicectomy was done, the lung cleared up and the whole syndrome vanished. In any event the doughy "feel" of the abdomen, the leukopenia, lymphocytosis and low blood-pressure should be helpful in the recognition of peritoneal tuberculosis.

It is understood, of course, that tuberculous appendicitis is not an infrequent affection, and is apt to be overlooked. It is usually secondary in origin and chronic in its aspect, but rarely may be primary or acute. Manifestly it would be impossible to determine the etiology beforehand, unless there were a primary tuberculous lesion elsewhere in the body. The percentage of tuberculous appendices removed by operation varies from 0.2 per cent to 3 per cent as given in the report of seven different surgeons.

8. *Diseases of the Female Pelvic Organs.*—Diseases of the female pelvic organs are much more readily differentiated from appendicitis when the two affections are both chronic than are the acute infections of each. The symptoms generally are more distinctive and examination is more satisfactorily made in the chronic types. Furthermore, not nearly so much is at stake since

in chronic cases surgical interference would be permissible in either condition; and both pelvic and appendical disease may coexist, needing equal attention.

In any given case, however, it may be a matter of difficulty, or even impossibility, to decide between a diseased right tube or ovary (or both) and a low-lying ("pelvic") appendix, chronically inflamed. Even ovarian cysts and uterine fibroids may be overlooked. In early pregnancy the pains of intermittent uterine contractions have been mistaken for chronic recurrent appendicitis. History of a previous infection, the location of the pain, and disordered menses will point the way. Pelvic examination should settle all of these questions. If in doubt one should reëxamine every female patient either per vaginam or per rectum, under anesthesia, before operation. Many errors both of omission and commission thus would be obviated.

9. *Tabes dorsalis, Spinal-Cord Root Irritation, Hysteria, Psychoneuroses, Endocrine Dysfunction.*—All these may demand differentiation from chronic appendicitis, according to their several characteristics. They must be eliminated or recognized, when necessary, in order to avoid error. Discussion of their relation to the diagnosis of acute appendicitis has already claimed our attention. The same points of interest would apply to the differentiation of the chronic forms only in a lesser degree and, therefore, under even more obscure conditions. There is need for most thorough investigation of these ailments before pronouncing an opinion upon the diagnosis of chronic appendicitis. Such an investigation would include complete blood and serological examination, search for focal infections, study of family characteristics, radiography of the spine, metabolic function tests, etc.

"In all painful conditions of the abdomen for which relief is sought," says Battle, "it is advisable to think of the appendix as a possible cause, for the large proportion of them are dependent upon disease of that part of the intestinal canal."

Under the title "chronic nervous appendicitis" Shelterna mentions seven cases of nervous disturbances—headache, melancholia, irritability, insomnia, dizziness, habitual constipation, general weakness, poor appetite, inability to think clearly, slight midday rise of temperature—all of which subsided after operative treatment of chronic latent appendicitis.

Cignozzi refers to the stunting of growth by chronic appendicitis, and notes dystrophy and infantilism of several adolescents which may be ascribed to the disease. Rapid development to normal took place after removal of the appendix.

Pseudo-Appendicitis.—In spite of the fact that Hertzler and others give credit to Aschoff for suggesting this term, it appears that Condamin and Voron first used "pseudo-appendix" to describe a condition which occurred normally in hysteric subjects or which might be associated with secondary syphilis. The latter type they classed with a form of intestinal neuralgia which Fournier had called "syphilitic typhosis." These authors thought it easy to distinguish the true and the false appendicitis if the possibility of the latter is kept in mind.

Included under this head are all those sundry symptoms described in the differential diagnosis of chronic appendicitis, particularly in reference to diseases of the colon. Pain is confined to the lower abdomen, although there may be fullness at the epigastrium; constipation is the rule, but it may take turns with a mucous diarrhea; a general depression of spirits and "nervous indigestion" exist; headache, backache and leg ache are present. The patient's attention has been directed to the appendix because the pain is "in the right side." Tenderness is present, but it is not constant and is quite variable in its degree. There are other sensitive areas, some elicited by deep and others by superficial pressure, all dependent upon a more or less hyperesthetic abdominal wall or visceral reflexes.

Very often these phenomena are developed in affections of the colon, as described previously. In some cases the symptoms are due to the existence of pericolic membranes, such as Jackson's veil, or ileal bands, as Lane's kink, etc., with or without direct involvement of the appendix.

The expression pseudo-appendicitis, or "false appendicitis," denotes a condition resembling appendicitis, but not the real disease. It implies an admission of inability to make a diagnosis, and so difficult the task and so futile our means that such an admission is by no means always blameworthy. There are no definite or uniform findings in pseudo-appendicitis. A group of conditions giving the simulating symptoms in one case may be entirely different from those exhibited in another. In his paper on the subject Highsmith regarded as pseudo-appendicitis any case in which the symptoms could not be rationally explained by some such condition as those already considered in the differential diagnosis of chronic appendicitis. His cases were usually young, thin adults from fifteen to thirty years old, about equally divided as to sex and between married and single, almost all neurasthenics with abdominal ptosis. It was his custom to operate upon the patients and afterward to keep them on medical treatment for a period of months. A malformation produced symptoms of pseudo-appendicitis in a case recorded by Dami. There were exacerbations of pain and marked constipation. At operation an internal hernia of the small intestine was found, located between the termination of the ileum and a peritoneal fold connecting it with the cecum and the appendix.

A recent rather extensive monograph by De Martel and Antoine takes up the question of pseudo-appendicitis in detail, containing minute observations upon fifteen chosen cases. In a collection of 124 instances of painful syndromes of the right flank and iliac fossa these authors found the lesions divided as follows: simple chronic appendicitis, 34; chronic appendicitis with various associated diseases, 6; Jackson's membrane, 4; union of two arms of colon in "double-barrelled shotgun fashion," 10; typhlocolitis, 9; simple cecaglia, 4; abnormally mobile cecum, 5; ptosis of the right flexure only, 5; ptosis of the whole right cecocolon, of which 5 caused duodenal compression by the mesenteric pedicle, 12; perivisceritis of the right superior quadrant, 10; perivisceritis of the right inferior quadrant, 14; Lane's kink, 2; simple spasm of the ileum, 2; postappendicitis omentitis, 5; ileocecal tuberculosis, 2. The clinical study brought out three types: mild attenuated forms; subacute forms; severe and long-standing forms. These give rise to symptoms in accordance with the extent of the pathological findings. Radiologic study was made systematically in each case, as the method of successfully determining the seat and nature of the lesion; but its importance was not exaggerated. Each lesion as above outlined was elucidated by signs and symptoms, with stress upon the differential diagnosis, especially the elimination of the appendix by blood findings, physical examination and radiologic study. The treatment advised is to determine those types of lesions best relieved by medical means, those amenable to surgical operation (fixed ptosis of cecum, omentitis, perivisceritis, Jackson's veil, colonic union); impressing the fact that surgery alone does not cure, but that all the patients need hygienic and dietetic care, both before and after operation and in lieu of operation. Surgical procedures advised depend upon the individual lesions present, but in general are done through a T-shaped median incision, the first portion from just below the xiphoid cartilage to a point well below the umbilicus, supplemented, when, as is usual, more room is needed for thorough inspection, by a second incision extending transversely from the anterior-superior iliac spine to the median line, cutting through the right rectus muscle perpendicularly to the direction of its fibers. Through this combined incision a complete exposure of the abdominal contents is obtained and any operation may be carried out according to the judgment of the surgeon.

Thus the term "pseudo-appendicitis" embraces a number of affections. It is here applied to that rather large variety of conditions connected with the ileocecal and right colic region which are not appendicitis. When we are able to rule out true appendicitis, whatever is left to produce simulating symptoms is false appendicitis.

Conceptions of Chronic Appendicitis.—Keeping in mind the discussion of chronic appendicitis in the chapters on Pathology, Symptomatology and Diagnosis, it may not be amiss to present further views bearing on the question as a whole. It is yet an unsolved problem in the minds of many. Much depends upon whether one considers the disease as a pathological entity only, as it appears to the naked eye or under the microscope; whether one judges entirely by the clinical symptoms; or whether one looks at it solely as a matter of differentiation from other more or less obscure affections. We have seen how inconstant are the signs and how perplexing it is to distinguish them from the same symptoms associated with different pathological conditions.

As before stated, the soundest view to hold is that chronic appendicitis always signifies a previous attack. It may be impossible to prove the attack, as its history can date far back; but it is worth an exhaustive search. Goebel takes this position when he says that chronic appendicitis is not a chronic disease of the appendix *per se*, but a chronic inflammation as the result of a primary acute attack, an *appendicitis cicatrisans retarda* (Schnitzler). Clinical observation has shown that such an attack is often not established, for many patients have either forgotten they ever had such an attack or had attributed it to some transient gastro-intestinal disturbance. And yet in the absence of such evidence, it does appear that chronic appendicitis may be chronic from the beginning. Deaver is insistent that it constitutes a clinical entity and a surgical fact, not a fancy, and names two types: the first following attacks of acute appendicitis, and the second being chronic from the onset. Carson feels that it is going too far to say that chronic appendicitis should never be diagnosed unless there has been an acute attack, but thinks the idea must be dismissed that the disease can be predicated upon right iliac pain alone. Starr considers a diagnosis of chronic appendicitis justified only when there is a definite history of a previous attack, dividing cases which simulate it into four groups, according to the pathological findings.

In a very thoughtful review Gaither concludes that chronic appendicitis is a distinct, widespread, often unrecognized malady; that it should be thought of in all cases of disordered digestion presenting motor and secretory symptoms, in every case of chronic constipation, in gastric upsets without definite ulcer symptoms, in intestinal dyspepsia and toxemic states. Without a comprehensive study of the patient, however, he believes it a great mistake to attribute all these disturbances to a diseased appendix, and particularly urges neurological investigation before assigning the symptoms entirely to organic causes. He considers the x-ray of very great value, but not "the court of last resort."

According to West the chronically inflamed appendix shows no uniform pathology, a definite diagnosis is impossible in the absence of acute attacks, the value of the x-ray is very doubtful, relaxation of the abdominal musculature of the right side is noticeable and tuberculosis is frequently mistaken for the disease.

That form of chronic appendicitis in which the symptoms are entirely masked has been termed *"appendicitis larvata."* Ewald who first described and named this condition in 1899, stressed one feature, *viz.*, that "the pain of which the patient complains leads him and the doctor in the first instance to anything but an illness originating in connection with the appendix." Pathologic changes may be observed in the removed structure, such as scar tissue with fibrous thickening, or even empyema of the appendix, but subjective signs are wanting for a clinical diagnosis.

Mueller considers that so-called chronic appendicitis is a condition that should be evaluated in the light of its effects on the whole human mechanism. The appendix is diseased in a very high percentage of cases: Aschoff claims in 75 per cent of all cases examined, while Oberndorfer states that in six hundred cases there were very few exceptions. The appendix is apparently first involved in some form of colitis. Frequently recurring, often insignificant, attacks lead to a round-cell infiltration in the muscular wall of the appendix. This evidence of inflammation is seldom to be recognized macroscopically, but it leads to scarring and stenosis of the appendix. If the appendicular lumen be not occluded, the exudate resulting from slight inflammatory processes is emptied into the cecum without any untoward consequences. If, however, this drainage is interfered with, the usual sequelæ of appendicular inflammation may supervene. As the result of the persistence of small foci of infection in the wall of the appendix with the resulting absorption of toxic products, there may occur the various signs of general intoxication, such as headache, dizziness and the various neuralgias. The organs of the female pelvis are particularly liable to secondary involvement. The author advises that in all chronic diseases of the abdomen the possible presence of a chronically diseased appendix be borne in mind.

As a gastro-enterologist Lichty pointed out the confusion that existed in regard to chronic appendicitis, according to whether it was considered by the pathologist or the clinician, and remarked that the prevention of the disease is easier than its cure. Clinically the results of his gastric analyses in 263 patients who had chronic appendicitis, proven by operation, were as follows: 71.9 per cent had hyperacidity, 17.8 per cent had hypoacidity, and 10.3 per cent had achylia.

Two recent reviews published simultaneously in the same journal, one written by an internist and the other by a surgeon, serve to bring the discussion of chronic appendicitis up to the present moment. In the first paper Boas begins by admitting "that every case of chronic appendicitis was at some time preceded by an acute forerunner"; then proceeds to emphasize conditions of the cecum, to which, he thinks, we do not pay sufficient attention, especially in relation to the part it plays in irritation of the autonomic nervous system. Further he shows that on account of this close relation of appendix and cecum it is impossible for the clinical picture of chronic appendicitis to be sharply demarcated; that the failure of pathologists to agree on the limitations between pathological and physiological changes in the appendix make classification very difficult; that the four diagnostic aids of abdominal point tenderness, palpation of the appendix, slight rises of temperature and roentgenological demonstration of the appendix are of questionable value; that in the present state of our knowledge more than a probable diagnosis cannot be made; that chronic appendicitis is not a pleasant disease either for the surgeon or the internist, because we are not masters of the situation.

Haberer, in the second paper, on chronic appendicitis from the surgeon's viewpoint, also supports Aschoff's contention that every chronic appendicitis is the natural result of an acute inflammation; thinks that this pathologico-anatomical question is difficult to work out on a clinical basis and on this account many mistakes are made; believes that the showing by the pathologist of the remains of a past acute process does not prove that these have produced symptoms, still less that they were observed and correctly interpreted; regards many cases of chronic appendicitis as part of a genuine colitis, either as cause or effect; gives due consideration to tenderness in the ileocecal region and agrees that finding residual filling in the appendix after the colon has been emptied should be called a pathological roentgenological finding, but is convinced that rises of temperature must be counted against rather than in favor of chronic appendicitis—chiefly from a suspicion of pulmonary tuberculosis. When the evidence is sifted, says Haberer, little is left of what may with a clear conscience be called chronic appendicitis, except: (1) Those cases in which, following one of several attacks of appendicitis, there develops a chronic change in the appendix, which continually produces symptoms; (2) those cases in which a chronic appendicitis exists without any *demonstrable* acute attacks having preceded it, the indurative, adhesive types (appendicitis larvata); (3) those cases of colitis which cannot be distinguished from disease of the appendix by any diagnostic means at our command, and which actually may be accompanied by chronic appendicitis. Haberer's estimate of the essence of chronic appendicitis is so keen and so in accord with the experience of practical surgeons that it is here quoted verbatim: "Finally there also belong to this group the cases in which the appendectomy is the first step to multiple laparotomies, of which every one, especially the first, had better be omitted. Generally, these most unfortunate victims of this abdominal polypragmasia are recruited mostly from that group of individuals who, at any time and for various reasons, imagine themselves to be suffering from an appendicitis. Unfortunately, after a more or less diligent search, they eventually find a willing surgeon who removes the appendix. Other surgeons, just like myself, no doubt also find cases, in which, according to the dictates of conscience, an operation is advised against, but which do not rest until the operation is performed by some one and then ruefully return to the surgeon who refused to do the operation because of their usually more severe pains."

The most pessimistic of all observers is Hertzler. He draws the following positive conclusions: (1) Fibrotic changes in the appendix, no matter of what degree, are not attended by clinical symptoms. (2) The anatomic structure of appendices commonly removed under the diagnosis of chronic appendicitis shows no variation from the appendices of individuals suffering from no abdominal complaint whatsoever. (3) The minimal changes alleged to be present in cases of so-called chronic appendicitis are wholly inadequate to explain the symptoms ascribed to them, considered in the light of like changes in other organs of the body. (4) Mere alleged relief of symptoms after the removal of the appendix is not sufficient to prove that the appendix was the cause of the symptoms. (5) The vast majority of patients so operated on do not even claim relief of their symptoms. (6) The symptoms alleged to be due to chronic appendicitis can be relieved by searching out the actual cause and by removing it, relieving the patient without molesting the appendix.

On the other hand, Selinger writes: "Chronic appendicitis is then not a mental condition. It is truly a pathological process, a symptom-producing disease. It requires study, a differential diagnosis."

Very philosophically Connell observes that chronic appendicitis with its unsatisfactory results is becoming a reproach and asks, what are we to do about it? His answer is, diagnose it. By effort at eliminating all the conditions simulating it, he finds it to be one of the most complex abdominal problems, deserving serious study before and not after removal of the so-called "chronic appendix."

Varieties of chronic appendicitis have been discussed from time to time. Casper presented the following divisions: (1) Those with previous attacks, running back sometimes for years, even to childhood. (2) Those with indefinite earlier attacks of a kind not typical appendicitis, but a sort of "belly-ache," the attacks occurring periodically, usually intermittently and irregularly. (3) Subacute appendicitis, in which there has never been an acute attack, with perhaps urinary disturbance, severe constipation or neuritis of the right leg. (4) True chronic appendicitis with no acute or subacute phase. This class includes those with general visceral misplacements, kinks and bands and pathological membranous formation and its attending states, and a certain amount of low-grade peritonitis. (5) Tuberculous appendicitis, which may be primary or extend from an adjacent tuberculous fallopian tube. It may be secondary to pulmonary tuberculosis. From the appendix the lesion soon spreads to the cecum and the ileum, followed by enlarged glands.

Young recognized three classes: (1) Cases showing a single severe attack, resulting in local peritonitis and adhesions. (2) Cases with mild multiple recurring attacks. (3) Cases without acute attacks, but presenting vague symptoms.

Finally the following conclusions, arrived at by Deaver and Ravdin, the end results of their experience in five hundred cases of chronic appendicitis, are offered as a fitting close to the chapter:

(1) Few cases of chronic appendicitis are observed in the first decade. (2) There is a variation of sex and age in the second and third decades. (3) The most frequent symptom is periodic pain in the right iliac fossa. (4) A normal appendix was removed in 3.8 per cent of the cases. (5) The symptoms of seven cases of tuberculous appendicitis and one of carcinoma did not differ in any way from the remaining cases in the series. (6) The mortality of the cases in which operation was performed during the quiescent period was 0.27 per cent, while in those operated upon during the acute stage it was 2.7 per cent. (7) There seems to be a definite relation between the appendicitis and upper abdominal disease and between it and pelvic diseases. (8) Hematemesis may be a manifestation of chronic appendicitis. (9) The average postoperative incapacitation was 5.73 weeks; 83.1 per cent of the patients followed up were entirely relieved, 9.7 per cent were partially relieved, and 7.07 per cent were unrelieved.

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CHAPTER VIII

COMPLICATIONS

The complications of appendicitis are those pathological processes arising during its course, not a necessary part of the affection, but connected either directly with it or due to independent causes. Such attending disorders may accompany appendicitis from the onset of the attack or even before, in many instances, as we have seen, clouding the diagnosis and obscuring the appendical inflammation; or they may appear during the progress of the disease, remaining to influence its course and to affect its outcome. Furthermore, important sequelæ may occur after operation, either from the surgical procedure itself, or as an inevitable result of conditions present before operation. Conversely, appendicitis not infrequently may complicate other morbid states and it is well to consider them in their co-relations.

Peritonitis.—First and foremost peritonitis stands as the complication which occurs more frequently and is more to be feared than any other. It usually results from a perforation of the appendix or a slow leak from its gangrenous walls; but may be due to extension of the infection by continuity of tissue.

It seems to be true that the peritoneum may be infected without rupture of the appendix into the cavity. McWhorter gave the views of various authorities on this subject and detailed five cases of his own. In two cases a large walled off abscess was present. In one of these a staphylococcus was cultured from the peritonitis. In two cases nearly all of the round-cells throughout the appendix wall contained organisms. He concludes that the occurrence of purulent peritonitis or abscess in appendicitis may occur without perforation of the appendix. All of the patients were young and were given cathartics during the attack. After experimental catharsis, engorgement of the intestines, ecchymosis and round-cell infiltration may occur. These changes were usually more marked in the cecum and were exaggerated by catharsis following laparotomy. Bacteria may extend throughout the wall of the appendix without ulceration of the mucosa. In the absence of perforation, more or less visible bacteria may be present in the peritoneal cavity.

Infectious peritonitis will occur sooner or later in all suppurative cases of appendicitis, very early in the fulminant forms, more tardily in those of slower development. Unless speedily relieved, every case thus complicated must be fatal. Diffuse or generalized peritonitis is recognized without difficulty—a resistant, boardlike condition over the whole abdomen, with intense tenderness and distention; a rapid, wiry pulse and an anxious facial expression. Lesser degree and more localized types of peritonitis present milder symptoms. Blumberg's sign is present in practically every case. The microorganisms concerned are the common bacillus of the colon and the usual pus-producing cocci. Pneumococcic peritonitis resulting from blood-stream infection with an uninvolved appendix is difficult to distinguish from an appendical peritonitis.

The end of every attack of appendicitis is either in recovery (only to recur in almost every case), in cure by early removal of the appendix, or in peritonitis when allowed to perforate or extend its infection, often then to be relieved by interference. The problem of appendicitis, therefore, largely is the avoidance of peritonitis, its ultimate complication.

Each one of the numerous conditions considered under the differential diagnosis may be present with a true appendicitis, acute or chronic, as one of the many possible complications. Some of these will now be described.

Intestinal Obstruction.—As stated before, appendicitis as a direct cause of intestinal obstruction has not been sufficiently emphasized. The most frequent method of its agency is by the formation of adhesions which cause an angulation or twisting of the bowel. More rarely the obstruction is brought about from the encircling of the small intestine by the inflamed appendix, constricting the lumen and giving rise to strangulation. When we think of the conditions present in every appendical lesion, it is a great wonder that more of these cases are not seen. Their scarcity is due very likely to the fact that the appendix is so seldom found pointing inward and lying in close relation with the small bowel.

Obstruction due to appendicitis is not always complete; rather is it inclined to be partial and less acute than that from other causes. It might be quite difficult to determine whether the case is a simple acute appendicitis, an occluded intestine, or both. As a rule the bowels are easily emptied by an enema in appendicitis, and, if this be not the case, intestinal obstruction must be kept in mind, while the appendix as a possible cause should not be lost sight of. In some cases in which obstruction is feared, peritonitis is producing the symptoms by its paralytic action upon the nervous mechanism of the intestine.

As a preoperative complication intestinal obstruction is often overlooked, not considered. Attention given to the terminal ileum and to the ascending colon and the sigmoid, freeing these when kinked or adherent, will reward surgeons by the prevention of many cases of postoperative obstruction. The minimal employment of drains and their proper adjustment when demanded, will result in lessening the number of intestinal occlusions. By such means fewer enterostomies, life-saving measures though they be, will be required.

A rare case is reported by Wegener. It was an ileus in a woman sixty-five years old produced by a cystic tumor of the distal end of the appendix wedged between the folds of the ascending colon. The specimen was a mucous cyst, the size of a goose egg, apparently of long standing, which had become occluded. Previous attacks of appendicular disease were included in the history. The clinical importance of the case is that the cyst, acting as a foreign body, led to severe obstruction symptoms. No instance like it is on record.

In a case of secondary obstruction occurring under his own care Oudard thought the cause may have been faulty invagination of the appendix stump and its encroachment upon the ileocecal valve.

What is regarded as intestinal obstruction due to organic, mechanical causes may be only a peritoneal infection. They are difficult to differentiate. The peritonitis cases are, of course, attended with a higher mortality rate.

In 1,011 appendix operations Warren encountered obstruction of the bowel thirty-four times either as an accompaniment or a sequel. Of these a certain number were associated with a loculated fibrinopurulent peritonitis. Two clinical groups were noted: the primary, of which there were thirteen cases, with no deaths; and the postoperative, twenty-one cases, with a mortality of 33⅓ per cent.

Mora refers to adhesions of the appendix associated with intestinal obstruction. These adhesions, he remarks, may be brought on by direct inflammation occurring in the various forms of appendicitis or by contiguity from inflamed adjacent viscera, chiefly the mesentery, ileum, cecum and abdominal wall. They may result from operation on structures in the vicinity of the appendix, where infection or trauma are the basic factors. He goes on to state that adhesions of congenital origin, while comparatively rare, are more common than ordinarily supposed. Individual peculiarities exist in regard to the reaction of the peritoneum to infection and trauma, little trauma in some people calling forth massive adhesions, while prolonged handling in others produces no reaction at all. Previous history of appendicitis is important in connection with suspected cases of acute obstruction.

Associated Lesions of the Upper Abdomen.—In grouping these together it is to be borne in mind that affections of the upper abdominal organs appear to be closely related to each other and to disease of the appendix. We have pointed out this connection in the chapters on Etiology and Pathology. Gastric and duodenal ulcer, gall-bladder infection, pancreatic disease and, in the light of late investigations, lesions of the liver—each or all—not only may complicate appendicitis, but also the one may cause the others. More often the infected appendix is guilty of producing disease in the upper abdomen rather than the reverse.

Clinically these complications may be observed as acute manifestations along with acute appendicitis, or perhaps more commonly, as slumbering lesions previously present for a longer or shorter period; or both appendix and upper abdominal organs may be clinically diseased. In either event one should not be surprised at the combinations and not unmindful of their import. Their several symptoms will usually be apparent. They have been discussed in the chapters on Symptomatology and Diagnosis.

C. H. Mayo believes that the appendix always should be considered a possible focus of disease involving the upper abdomen and that, if the patient is suffering from stomach trouble due solely to pylorospasm or, if the gall-bladder or stomach be found healthy, the appendix should be examined, as it may be the sole cause.

As Deaver has noted, in the early stages of chronic appendicitis the upper abdominal symptoms are reflex in character: the pylorospasm, pain, vomiting, discomfort and even hematemesis may all be due to a nervous reflex or to the effect of toxins from the appendix on the upper intestinal tract. The same symptoms, however, may be due to organic lesions, such as cholecystitis, gastric and duodenal ulcer and chronic pancreatitis which have resulted from a neglected appendix affection.

Delicate discrimination is needed here to determine between a functional disorder and an organic lesion.

Deaver further calls attention to the fact that acute infection of a high-lying appendix may spread directly to other viscera of the upper abdomen, as in acute cholecystitis by contiguity of structure. The subphrenic and subhepatic regions may be infected either through the lymphatics, which is rare, or by extension of the appendical infection up and along the outer side of the colon. The liver itself becomes infected either by transmission through the portal vein or by direct transmission of bacteria along the lymphatics into the liver substance; for there is a lymph channel leading from Glisson's capsule into the parenchyma, in a small zone of the right lobe of the liver. Portal thrombosis and pylephlebitis are not infrequent, with gangrene or infection of the meso-appendix. Infection also may extend to the spleen.

In a study of 350 cases with symptoms referable to the gall-bladder, duodenum and appendix, Quimby was of the opinion that focal infection is the most satisfactory explanation for the majority of these cases. With the appendix a blind pendulous tube, the lodgment of bacteria in it is easily conceived, and no authoritative statement has been found as to the channel through which the bacteria enter the gall-bladder. The portal circulation and lymphatics have been named as being responsible. The direct ascension of the bacteria through the ampule of Vater, just as bacteria ascend from the urinary bladder to the kidney, is a rational supposition. Of this entire series of cases in only 7 per cent were gastric and duodenal ulcers found, including old and new ones. Only two cases exhibited gall-stones, one had jaundice. Eight cases showed distinct evidence of pancreatitis, and in each of these there was some form of dry skin disease.

Moore reported a case in which perforation of an acute gastric ulcer took place during an attack of acute appendicitis.

Writing upon the "abdominal triad"—duodenal ulcer, cholecystitis and appendicitis—Zweig presented thirteen examples confirmed by operation and referred to nine others in which at least one of the three was overlooked and finally cured by medical means alone. He assigns a common cause for all—an infection entering from the intestinal canal, involving the appendix or the gall-bladder alone and assumes that duodenal ulcer is the result of a retrograde embolus.

Time after time the appendix is accused, it may be justly, and removed when later symptoms of gall-bladder infection or duodenal ulcer may flare up, necessitating a second operation. In some cases the upper abdominal infection was already present; in others it had not arrived; in many the appendix was doubtless the starting point. Every one of these instances is related. Much depends on the time elapsing between the operations. It is possible for the infection to be entirely separate. Yet, looking back on many cases, one can feel sure the complicating lesion was present at the time of observation. Cases like that reported by Bertone are not infrequent. He had a female patient, of twenty-nine years, who was admitted with a diagnosis of acute appendicitis. She gave a history of frequent attacks of indigestion covering a long period. Operation showed a perforated purulent appendix. She recovered completely and resumed her household work; married and had two children with normal labor. Six years after the appendix attack she was seized with a violent cholecystitis which again necessitated operation. The gall-bladder was highly inflamed and contained a large stone. She promptly recovered. From the history of early attacks of indigestion and other gastro-intestinal disturbances in this case, the writer thinks there was an etiological relation between the two diseases.

Absence of the normal bile content in the intestines, according to Moore, may cause an inhibition of the normal resistance to bacterial invasion, so that infection of various types are free to gain access to tissues of already weakened vitality. This is especially true, he holds, in cases of general visceroptosis. The downward tendency of all the abdominal organs with the resultant pull on mesentery and omentum and frequent kinking of various structures, leads to impaired circulation and much lowering of resistance. With the resulting tendency to constipation, there is considerable absorption of toxic substances and a secondary toxemia or auto-toxemia, frequently involving the appendix in inflammatory conditions.

Acute Fulminating Cholecystitis.—An acute fulminating cholecystitis occurring simultaneously with an attack of acute appendicitis presents a perplexing problem. One is at a loss to decide which is the original disease and which the complication. A case of this type once forced itself upon us at the operating table, when after removing an acutely inflamed edematous appendix, exploration revealed an enlarged gall-bladder, tense, acutely infected. Agreeing in the consultant's advice that it would be good surgical judgment to leave the upper abdomen for another operation, I closed the incision without molesting the gall-bladder. But the patient developed a rapid local and general infection, with jaundice, and died five days later. Such questions continually will arise. Nine times out of ten an acute cholecystitis will subside and it is not universally regarded as wise to interfere during the infective stage; while it is the customary rule to operate for acute appendicitis in its active period. Perhaps in the case just mentioned we allowed the tail to wag the dog. The particular point in this instance, no doubt, was that the infection originating probably in the appendix, developed immediately in the gall-bladder and almost certainly in the liver, too, and did not constitute a distinct, independent complication.

Appendicular Liver.—This brings us to a consideration of the infections of the liver resulting directly from the appendix. The processes may be either acute or chronic in each respect. This phase of upper abdominal complications is assuming important and interesting proportions.

For some years Heyd has insisted that long-continued infection of the appendix is associated with definite pathological changes in the liver. He found in the very mild cases an infiltration around the portal venous radicles, followed by some degeneration of the hepatic cells and fibrous tissue replacement; in the more chronic cases or those of greater virulence of infection, but still essentially chronic, there was infiltration around the biliary radicles as well. In all the cases morbid changes were noted in the gall-bladder and the liver exhibited the surface markings of interstitial hepatitis. When acute exacerbations occurred in the appendix, the infiltration in the liver was merged with a polynuclear invasion, accompanied by a diffusion of leukocytes, lymphocytes and endothelial cells between flattened and distorted liver cells.

Elliott (discussing Heyd's paper) emphasized the tremendous regenerative and adaptive power of the liver, in that the extent of pathologic change does not parallel functional change and that marked infiltration may be present without impairing liver action. Lichty, following, asked if a general subinfection might not be responsible for the lesion in both the chronically diseased appendix and the liver, and suggested these deep infections of the liver as a plausible explanation for so many failures to cure chronic appendicitis, for the removal of the appendix will not restore liver function. Heyd acquiesced in the subinfection theory, adding that all of his cases of pathological livers showed a chronic appendicitis.

The very first work tending to show the close relation between infection of the liver and the appendix was done by Dieulafoy. His work is still foremost. The term, "appendicular liver," was applied by him to toxi-infection of the liver following appendicitis. Distinction was made between toxic and purulent hepatitis: (*a*) Toxic hepatitis, or appendicemia, comes on early, as the result of absorption of the toxins through the portal vein, is associated with jaundice and frequently with albuminuria, does not advance to suppuration. The jaundice is of hematogenous origin, not marked or of long duration, disappearing promptly after the appendix is removed. It may lead, however, to a general toxemia. There is no pain over the liver and the symptoms are not violent. (*b*) Purulent hepatitis, on the contrary, is ushered in by chills, fever and severe pains in the upper abdomen. It appears late, due to infection by actual bacteria in the veins, is characterized by deep jaundice and a rapidly enlarging liver, and goes on to pus formation. Abscesses of the liver—usually multiple, occasionally solitary—constitute the end result, and are almost invariably fatal. Dieulafoy considers hepatic infection one of those remote infections peculiar to appendicitis. He lays tremendous emphasis upon the danger of liver complications even in the supposedly mild attacks of appendicitis, holding that by the "exaltation of virulence" and increased expansion in the closed canal of the appendix the bacteria are able to penetrate its walls or to migrate through the blood-vessels. It is the latter process that is more to be feared than periappendicular invasion. Here is one of Dieulafoy's striking statements: "Peritonitis is not the all-important complication in appendicitis. We must take account of the toxic complications which sometimes precede the infectious troubles. They are the most to be feared as 'temporizing' surgery is powerless against them."

Liver involvement must be looked for after the acute phase has passed. Dieulafoy did not know of a single example of hepatic infection beginning quickly during the early stage of appendicitis; he believed that the microbes did not enter the veins of the appendix before the fifth or sixth day. Toxins are sucked up much earlier than the bacteria into the portal venous channels and, if the bacteria do not follow, the process may resolve into toxic hepatitis previously mentioned.

Recent research and discussion have served only to confirm Dieulafoy's observations. We are now going behind the returns and finding that liver infection furnishes an explanation of some hitherto uncertain complications and a stronger reason for early operative interference even in the mildest cases. Practically an understanding of the "appendicular liver" enables one to determine what may or may not be done when the abdomen is opened upon pathology involving the appendix and the organs in the upper right hypochondrium. Appreciation of toxic and infective hepatitis in relation to appendicitis leads to a proper disposition of each case as it appears for consideration. Among a number of illustrative cases, one made a striking impression on me. A boy of fourteen years was seen in consultation for what appeared to be an acute cholecystitis—epigastric pain, high fever, hyperleukocytosis, tenderness in the right upper abdomen; in twelve hours the appendix region was quite as tender, but there was a palpable mass below the ninth costal cartilage. On the second day, just before operation was done, pressure over the right iliac region produced pain transferred to the epigastrium. Abdominal incision disclosed a large liver, pale, mottled, showing grayish white streaks radiating toward the notch; a tense, yellowish gall-bladder, one palpable gland at its neck; a 5-inch edematous appendix dark in its distal fourth, red and slimy, its cavity closed, containing two or three drops of pus, and its mucous membrane studded with petechiæ. After removing the appendix and deliberating over the affair, I decided not to proceed further, not even to drain the gall-bladder, judging the appendix to be the original source of infection and the operation to have been performed in time to be of avail. Two years have elapsed and the patient, who made a quick recovery, has been in greatly improved health. He has had no abdominal symptoms of any sort since the operation and has gained 28 pounds in the intervening two years.

"Liver Symptoms from Latent Appendicitis" is the title of a communication by Poenaru-Caplesco. He was impressed with the clinical picture in seventeen patients suffering from apparent liver disease, which subsided at once after appendicectomy. In one case there were pain in the hepatic area, vomiting, slight icterus and an occasional chill, all of which kept returning under treatment, at times with high fever and loss of weight; in all there was fever for one or two days, but no pain or other signs in the appendix region. Latent appendicitis was diagnosticated by exclusion. This author calls these patients "false hepatiques."

"The appendico-biliary syndrome" is the subject of two or more articles by Emmert. He thinks that the relations between appendicitis, hepatitis and cholecystitis are such that we must no longer consider gall-bladder disease a distinct clinical entity but part of a syndrome. The appendix he regards as the primary cause of this complex in 75 per cent of the cases, and abscessed teeth, tonsils and sinuses of the remaining 25 per cent. A fact of importance "is that the veins from the gall-bladder empty into the portal vein, so that we have an anatomical basis for a vicious circle after the liver is infected." Emmert thinks that most cases of so-called catarrhal jaundice are due to a hepatitis, a low grade of which is frequently responsible for the "reflex symptoms" in appendicitis and often clears up after removal of the appendix. His sequence here is expressed by primary infection in the appendix; hepatitis is the secondary infection; cholecystitis, the tertiary.

Extension of appendical infection to the liver may occur by way of the venous channels through the mesenteric and portal veins, through the retrocecal tissue, and within the abdominal cavity itself, when a subhepatic or subphrenic abscess involves the liver. The most frequent path is the hematogenous.

Pylephlebitis.—Pylephlebitis (inflammation of the portal vein or any of its branches) is one of the most serious complications that may befall. It is almost invariably fatal. Luckily it is not a frequent occurrence, not nearly so as it was in former days, when delayed operations or no operations at all were the custom. If the inflammation of the vein reaches its height without the occurrence of septic thrombi or the formation of a liver abscess, hope can be entertained that recovery may ensue. So rarely are these cases now encountered that no one observer has, or desires to have, wide clinical experience of them. Generally these infections come as a late manifestation.

Petren divided them into three groups, based on the stage of onset: (1) The first group consists of those cases in which no operation was done for the appendicitis, in which the early symptoms of liver infection are noted in the first days of the disease. In these cases there is continuous localization of pain in the epigastrium, increased bile pigment in the urine, icterus and febrile remissions. (2) The second group are the cases in which appendicectomy was performed, the patient doing well with the best outlook for recovery, when suddenly after a few days or even one to two weeks, severe symptoms set in, which with great certainty point to abscess of the liver. (3) The last group comprises cases of appendicectomy in which the liver complication appears after five or six weeks.

Nossen presents an example of each group with comment. The first case was that of a woman of twenty-one years, who had been under observation four weeks before the diagnosis of liver abscess was made. It was thought to be of perityphlitic origin and the appendix, though not much changed, was extirpated. The only enlarged vein on the median side of the colon was ligated, though no thrombosis was found. On transpleural freeing of the liver, he found the pleura, diaphragm and surface of the liver so agglutinated that they could not be separated. Incision of the liver surface showed purulent masses, and further penetration yielded thick yellow pus. Puncture of another portion of the liver surface also showed pus, and a blunt outlet was made into the liver substance. The patient died four weeks afterwards. The second patient was a boy of twelve, operated upon for gangrenous appendicitis, with a large abscess and a fecal stone at the site of perforation. He ran a septic course up to the sixth day and died from exhaustion. Autopsy showed an encapsulated focus between the liver and the diaphragm and the liver was traversed by many whitish yellow pus foci up to the size of a walnut. The portal vein contained several blood-clots firmly adherent to its wall. There was no peritonitis. The third instance was in a man operated upon six weeks previously. Threatening symptoms appeared suddenly, violent chills and high temperature. The following day appeared right exudative pleuritis, severe pains in the right shoulder joint, but no clinical signs on the part of the abdomen. On the sixth day the temperature had dropped and puncture was made in the subphrenic space with negative results. Not until the eighteenth day was another puncture made. In the last intercostal space behind the scapula thick pus was found, though the diaphragm was normally placed and the liver dullness normal. Transpleural incision showed abscess in the liver and the peritoneum free from pus. The patient died three days later from peritonitis.

Prompt recognition of this dreaded complication is much to be desired; but, as Nossen remarks, the early diagnosis is difficult, as it is almost impossible to differentiate clinically between progressive pylephlebitis and abscess of the liver. Often sudden, high temperature with continued remittent fever, rapid pulse, frequent irregular chills and sweatings are the forerunners of liver infection, which are clinically recognized only when the local signs appear in the liver itself. Icterus may then be prominent. The clinical picture of the late stages shows the well-known symptoms of marked exhaustion, emaciation, characteristic abdominal facies, vomiting, enlargement of the liver and of the spleen, costal respiration, pleural effusion, damaged heart, septic temperature curve, sometimes circumscribed edema of the skin.

Periodical literature is fairly full of papers upon acute infections of the portal vein and the liver, but most of the published articles date back of five years ago. Few of the textbooks, however, have stressed the grave importance of pylephlebitis and hepatic abscesses and especially their early recognition. In 1903 Gerster was one of the very first to point out the occurrence of chills as an early symptom of pylephlebitis and to suggest exposure and evacuation of the thrombosed veins. It will be recalled that in a previous chapter we mentioned the appearance of a chill in the beginning of acute appendicitis as indicating gangrene. This is associated practically always with plugging of the veins in the meso-appendix; chills coming later after operation, or even before, should arouse suspicion that thrombosis of the portal vein has taken place or is next in order.

From Halstead's clinic Christopher reported a case of pylephlebitis of appendical origin simulating lung abscess, in which the sole symptoms on admission were chills and sweats. With a history of influenzal pneumonia three weeks before and signs of chest involvement the natural assumption was pulmonary infection. A fairly normal gall-bladder was drained, and fluid was aspirated from the left chest; no other operative procedure was carried out. There seemed to be no reason to suspect the appendix. The diagnosis was revealed at the necropsy, after the patient had been forty-one days in the hospital. There was an infected thrombus in the portal vein, multiple abscesses in the left lobe of the liver and a retrocecal gangrenous appendix, connected with a pus collection between the pancreas and the duodenum. Christopher discusses the incidence of appendical pylephlebitis apparently believing that it occurs more frequently than is generally supposed. He notes the following different percentages by various observers: Gerster, 9 times in 1,187 cases; Fitz, 11 in 257 cases; London hospitals, 10 in 2,714 cases; Gibson, 1 in 782 cases; Brown, 12 in 9,494 autopsies. Munro (1905) reported 9 cases and estimates that abscess of the liver occurs in 5 to 10 per cent of cases of appendicitis. While this seems now too high an average, yet many do go unrecognized and a few early infections may recover without coming to light.

My impression coincides with Christopher's that numbers of these cases are diagnosed as septic pneumonia and empyema. I can look back on those of many years past and recall some of more recent times in which without doubt this confusion existed. They all ended fatally. I do not regard the condition as a frequent complication of appendicitis. It is most often to be looked for when there is an acutely inflamed, edematous, gangrenous appendix, retrocecally located and pointing upward. The communication is by the direct venous channels—appendical, ileocolic, mesenteric, portal; the toxins first and then the bacteria are sucked up, so to speak, rapidly until they reach the liver areas where the damage is done.

Along with Christopher and in line with Gerster's almost forgotten observation, Thalhimer emphasizes the early occurrence of "chills in appendicitis before operation and their indication of a probable stage of pylephlebitis." His studies suggested that the portal infection may have developed by the time the operation for appendicitis is performed, proven by the thrombi found in the veins of the meso-appendix and those tributary to it. He proposed, therefore, and executed in three cases, the exposure of the ileocolic vein and its branches through the parietal peritoneum and ligation of the vessels, if patent; incision and evacuation of the thrombi, if present. In a fourth case a second operation for evacuating the thrombus, evidenced by microscopic examination of the mesenteriolum after removal, was refused and the patient was brought back to the hospital three weeks later with several large liver abscesses. These were drained and the patient did well for a while, but later on developed a foul purulent expectoration and died four months after the original attack. As far back as 1913 Braun had recommended ligation of the ileocolic vein in those cases of purulent inflammation of the appendix in which chills and icterus indicate transmission of the pus generators into the blood stream. Braun saw only eight cases of pyemia in six hundred appendicitis cases and ligated the vein in two who recovered.

It seems to be a mooted question, says Braennig, whether the procedure had the favorable result or whether the removal of the gangrenous appendix would not have been sufficient in itself to have had the same favorable outcome. No other cases are reported in the literature and Braennig, therefore, reports his own experience. He operated on five cases of pyemia, originating in the appendix. They had chills and severe general septic infection, with relatively little local findings. The first one was the severest, with thrombosis of the ileocolic vein, which was ligated, but the patient died on the twenty-first day. The others all recovered; chills ceased after ligation. Where a purulent thrombosis of the ileocolic vein is found it is recommended by Braennig that the free abdominal cavity be shut off from the field of operation and the abdominal wound left open. But he contends that ligation of the vein is indicated in all cases where chills accompany an epityphlitis.

Comment upon this procedure may be limited to the observation that only a comparatively small number of such cases develop from a thrombosed meso-appendix and that a complete excision of the mesenteriolum would suffice to check the process. It might be argued, too, that opening of the posterior parietal peritoneum would favor the extension of any appendical infection to dangerous areas.

A decidedly more encouraging tone is seen in a very recent paper by Colp. He realizes that the prognosis in pylephlebitis complicating acute appendicitis is grave, but insists that it is not hopeless. When recognized before operation, ligation or preferably resection of the ileocolic vein is indicated, before removing the appendix; when it occurs after operation, surgical intervention is practically useless unless there develops a liver abscess which may be drained. Colp demonstrated the importance of researches by Charpy supplemented by the work of Pick that the veins in the gastrohepatic omentum ("hepatopetal veins") are capable of carrying on the circulation to the liver in portal occlusion. Ligation of the portal vein in pylephlebitis proved of no value and is never indicated.

A unique case is reported by Galbraith, in which the appendix was literally "pinned" to the liver, resulting in deep infection with a fatal termination. His patient, a boy of eleven, suffered from upper abdominal pain and difficult breathing; there was general abdominal tenderness, but more marked in the right hypochondrium. The diagnosis was inflammation of a "high" appendix.

At operation the cecum was found raised out of the right iliac fossa and slightly pulled upward by a tight band which lay on the surface of the ascending colon. This band was the appendix. It was ligated and the stump burned at its proximal end and then dissected up towards the liver to which it was firmly adherent and from which it came away with a jerk. From its tip projected a pin which was stuck into the liver substance. The pin was extracted and a drainage tube placed down to the puncture area. No abscess of the liver was evident. Three days later the patient had chills, fever, rapid pulse and jaundice, and died in a few hours. Autopsy demonstrated multiple confluent abscesses in the right lobe of the liver.

Eliason's recent report makes a distinction between pylephlebitis and abscess of the liver, which many writers seem to have regarded clinically as synonymous. There are four channels he describes, through which liver abscess may arise—the portal veins, the hepatic artery, the bile-ducts and possibly, though not demonstrated, the lymphatics. When the hepatic artery is the way of entry the abscesses are small and multiple, and the patient dies from the original blood stream infection; when the bile-ducts carry the infection, the abscesses occur around the biliary stem and pus is seen in the ducts; when the lymphatics are the carriers, diffuse peritonitis is present; only when the infection travels via the portal vein can there be both pylephlebitis and hepatic abscesses—and even then the two conditions are not always associated. Eliason operated upon fourteen cases (twelve of liver abscesses, two of pylephlebitis) and seven of them lived, exactly 50 per cent mortality; not so low as in one previous collection, but low enough to give us pause, since "many textbooks state that pylephlebitis is practically invariably fatal." Two startling facts stood out: in every case a tentative, and often a retained, diagnosis of pneumonia at the right base was made and a positive operation-demanding diagnosis was very tardily developed in all cases. This writer's conclusions may be summarized: This complication occurs in from 0.1 to 0.4 per cent of acute appendicitis cases; the x-ray is a distinct aid in early diagnosis when a high diaphragm is shown; local edema and prominent veins are valuable diagnostic signs; absence of pain, as a rule, is suggestive, except when the infection is in or on the upper surface of the liver; jaundice is almost constantly present and lassitude and anorexia are important factors in the diagnosis; the prognosis is not universally bad; operation through the diaphragm is the method of choice,

A case reported by Farmer ended favorably. The patient was operated on for acute appendicitis, and did well until the sixth day, when temperature and pulse rose with pain in the right flank. A round-worm was passed by the bowel, and next day 230 c.c. dark blood per rectum. A mass was palpable in the right hypochondrium; the patient was intensely jaundiced and in a critical condition. The abdomen was opened. High up in the right kidney pouch a pocket was evacuated, containing dark blood and a small quantity of purulent fluid. It was impossible to locate the source; two large drainage tubes were inserted and the abdomen closed. The patient was in a desperate plight for three days, then rallied. On the thirteenth day she developed pleural effusion and 16 ounces of fluid was aspirated. A gradual recovery ensued.

This infection was recognized early and the operation was prompt—far ahead of the usual course of events.

Swindell reported two cases of purulent hepatitis. One began with chills and high fever two weeks after operation for acute gangrenous appendicitis when the patient was up and around; a second operation was done but nothing was found; one week later there was recurrence of chills and jaundice, with enlargement in the hepatic region. The patient died and autopsy revealed multiple abscesses of the liver. The other case also followed an operation for gangrene of the appendix, coming on two weeks afterwards with jaundice, but without chills. The postmortem findings were the same as in the first case.

Halstead reports a case of solitary abscess of the liver successfully operated upon in two stages ten days after suppurative appendicitis. There is a wide difference in the mortality rate between the solitary and the multiple abscesses. Very few of the latter recover; many of the former respond to incision and drainage.

Subdiaphragmatic Abscess.—A very disquieting complication is a subdiaphragmatic, or subphrenic abscess. As its name implies, it is a circumscribed collection of pus, resulting from inflammation of the under, or peritoneal, surface of the diaphragm, involving also the serous aspect of the liver and the spleen. Acute suppurative or gangrenous appendicitis is its chief cause. The patient, otherwise doing well, will usually show few if any subjective symptoms, except a rise of temperature about the eighth or tenth day, with a high percentage of polynuclears and total leukocytes. The physical signs are tardy in developing and difficult to determine. Both abdominal and thoracic phenomena are present; the former comprise a possible projection during respiration, fixed dullness, slight rigidity, and deep tenderness in the upper right abdomen; the latter, dullness in the lower chest region with pushing of the lung upward, diminished or absent tactile fremitus, pulmonary sounds, and vocal resonance.

A very important sign is that suggested by Hoover, to distinguish this condition from empyema of the thorax, at times a difficult proposition. He observed that in empyema the lateral range of chest movement is limited, while if subdiaphragmatic abscess is present this movement is increased. Fluoroscopy furnishes valuable information by demonstrating the lack of, or limited, excursion of the diaphragm.

Kinlaw records an instructive case. A boy of eight, admitted with a diagnosis of empyema, had been sick twenty days and symptoms and physical signs agreed with the diagnosis. Five hundred eighty c.c. of pus were evacuated by a needle inserted at the angle of the scapula in the seventh right interspace. There were no special abdominal symptoms. Death occurred the next day. Autopsy showed bronchopneumonia, acute fibrinous pleurisy, subdiaphragmatic abscess, gangrenous appendicitis, localized suppurative peritonitis, acute diffuse nephritis and acute toxic splenitis. The appendix, 7 centimeters long, was retrocecal, pointing toward the liver and gangrenous. From it ran a straight tract, terminating in a large subphrenic abscess which was situated intraperitoneally in the right posterior subphrenic space. About 100 c.c. of pus remained in the abscess cavity.

One should not be surprised to discover both empyema and subphrenic abscess existing simultaneously, for the latter has been known to rupture into the pleural cavity, or even to invade the lung itself. Strictly speaking if the pus collection forms immediately under the diaphragm it must occupy that restricted space between the midriff and the upper surface of the liver; but the purulent mass may be subhepatic, subsplenic, or perirenal and still be classed under the present head. Exact anatomical location has less influence upon the symptomatology than upon the treatment.

For all practical purposes subphrenic abscess has been described as any pus accumulation, having the inferior surface of the diaphragm as one of its boundaries. The falciform ligament divides the subdiaphragmatic space into a right and left half and these are subdivided by the lateral ligaments into an anterior and a posterior compartment. Then there are two extraperitoneal areas, one on the right and the other on the left side of the body. These six compartments have much to do with the "pointing" of the abscess and the direction for its drainage.

Aschner insists that pus collections lying below the right lobe of the liver, in front of the kidney and above the hepatic flexure of the colon, that is, in Morison's pouch, are not truly subdiaphragmatic, but should be called subhepatic abscesses. The grave signs of toxemia are not generally present as in the real subphrenic type. Since the collection settles in the kidney region, Aschner advises a loin incision for its relief.

Pressley's review gives credit to Barlow in 1845 for the first account of subphrenic abscess, to Volkmann for operating on a case thirty years later and to von Leyden in 1880 for the first clean-cut preoperative diagnosis. Pressley analyzed 1,204 collected cases and of these 322 were due to the appendix, 280 to the stomach, 181 to the gall-bladder, 82 to the duodenum and 45 to the spleen; the causes of the rest were scattering. The reviewer found the mortality to be from 23 to 36 per cent, thought the diagnosis could best be made by exclusion after searching elsewhere for a suppurative collection, and noted that the death rate depended on the time of operation. His operating epigram is worth repeating: "If too early you miss the pus; if too late, you miss the patient."

Analyzing a series of seventy-eight cases (forty-three males and thirty-five females) Fifield and Love found thirty of them resulting from appendicitis. The right extraperitoneal and the right posterior location were equally frequent, occurring in twelve cases each, and the right anterior six times. The colon bacillus and the staphylococcus were the most common oganisms. The tendency of a right extraperitoneal abscess to extend forward between the layers of the falciform ligament was noticed in two cases, which suggest a possible route for drainage without involvement of the peritoneal or pleural cavities. The mortality in the series was exactly 50 per cent; but, eliminating those cases which died before operation, out of fifty-nine cases operated upon thirty-nine recovered and twenty died, a death rate of 32 per cent.

Location of the probable presence of pus by physical examination is to be followed by the introduction of a large caliber exploring or aspirating needle deeply into the middle of the mass. If the tapping is successful, incision and drainage are indicated; if not, either repeated trials by the needle are advisable until the pus is found, or operation may be done any way. In some cases incision may be made primarily without previous exploration by the needle. In many instances the utmost difficulty may be experienced in attempts to locate the abscess either by puncture or incision. A case recently reported by Clute illustrates the reward granted to patient and persistent effort to locate a subdiaphragmatic abscess. Following the removal of a gangrenous appendix the patient's preoperative fever did not disappear, but continued between 101° and 102° F. until the twelfth postoperative day, when by x-ray examination there was diagnosed fluid in the right chest. Tapping removed this, but it was clear, serous, sterile. Not until a month following the operation, after repeated punctures, was pus located in the subphrenic space. Transpleural incision in two stages was accomplished. Clute felt that pus would be found when the fluid was evacuated from above; for, he says, "It is almost always true that a simple serous pleurisy will be present in the chest when there is pus just beneath the diaphragm." This observation enforces a suggestion that the discovery of pleural pus either by the x-ray, physical examination or needle, should not satisfy the clinician, that this effusion is the cause of the symptoms (rather an accompaniment), or deter him from further search.

Acute Yellow Atrophy of the Liver.—A condition even yet little understood, this is a rare complication of appendicitis. It is allied in its symptoms to the conditions previously described, showing jaundice; but usually there are hemorrhages from the skin and mucous areas. The liver becomes shrunken and soft, while its cells are infiltrated with fat. Serious infections and toxic degenerations, as of chloroform and phosphorus, are responsible for the disease. Behrend notes the following case: A girl of sixteen years suffering all the cardinal symptoms of acute appendicitis, had been sick for two days. She was operated upon on the third day. The appendix was gangrenous and the pelvis contained pus. For the first twenty-four hours the temperature was normal; but the following morning the skin was slightly jaundiced, with rise of temperature and pulse. She vomited a little, then became delirious, gradually weakened and died on the third day. Autopsy showed acute yellow atrophy of the liver, with fatty degeneration. Two factors, says Behrend, could have caused the fatal complication, a late poisoning due to chloroform anesthesia, or the severe appendicular infection. It is impossible to come to a definite conclusion, but the cause seems to point rather strongly to the anesthetic.

Pancreatitis.—Pancreatitis may complicate appendicitis, but only as a very rare incident or as an accompaniment of liver and gall-bladder infections.

Hematemesis.—Among other complicating conditions, to be regarded as a symptom rather than as a disease entity, is hematemesis. Vomiting of blood does not necessarily mean ulcer of the stomach or other organic lesions of that organ. Often it occurs in appendicitis, chiefly in the chronic variety, now and then in the acute. I have observed it in three instances a few days after operation for acute gangrenous appendicitis, and many times in the course of chronic disease of the appendix without associated demonstrable lesion of the stomach or duodenum. Undoubtedly in some cases there are erosions of the gastric mucosa or even acute ulcers which heal rapidly with no organic remains. These ulcers in turn may be due to focal infection by way of the appendix, toxic lesions, based upon Dieulafoy's suggestion. As a complication, bleeding from the stomach generally is not of serious import in the absence of severe gastric disease. The vomitus is tinged with blood, comes in coffee-ground clots, or is a free hemorrhage in moderate quantities from time to time. Severe hematemesis is designated by Dieulafoy as "appendicular black vomit," amounting to a half pint of blood and at times resulting fatally. In these cases are found ecchymotic patches in the stomach mucous membrane, produced, he says, by appendical toxins, and the hemorrhage is precipitated by evident "ulceration of the arterioles ramifying under the muscularis mucosæ." Hematemesis may be independent of other toxic manifestations of appendicitis, but often is associated with jaundice, albuminuria, etc.—a part of the "toxic syndrome of appendicitis" (Dieulafoy).

Melena.—Melena also may complicate appendicitis, especially when diarrhea exists along with mucous discharges. The chronically inflamed pelvic appendix is prone to produce small, mucous, blood-stained stools by irritation of the rectum. There may be a toxic ulceration of the colon as is seen in the stomach, giving rise to copious hemorrhages. From a total of fifteen cases Bassler stresses two very marked instances. One was a woman, aged twenty-two, exhibiting long-standing hemorrhages from the stomach, fourteen in seven months; the other a severe case of continued bleeding from the lower bowel, so-called colitis, both cleared up in a week's time after appendicectomy. None of the patients gave ulcer histories, and nearly all showed a diagnosis of ulcer by x-ray. The pathological changes are a diffuse chronic inflammation in the gastric walls, a hemorrhagic mucous membrane and lymphoid hyperplasia; the "pyloric blush" encircles the whole stomach in this region and a conspicuous edema is present. Bassler's belief is that removal of the appendix in these cases will do away with the need for appendicostomy and exclusion of the colon.

This report is in line with my clinical experience. Numerous cases of hematemesis and melena, either singly or jointly, have been relieved by a simple appendicectomy. Several patients with chronic "stomach trouble" accompanied by vomiting of blood and many with "chronic diarrhea" or "colitis," showing bloody stools, yielded after removal of the appendix. Seldom has it been my lot to find any morbid changes in the stomach or colon to explain the hemorrhagic complication. It seems correct to assume that the process is metastatic, originating in the toxic appendix. An instructive case is recorded by Frick and Irland. The patient was a woman of forty-six years, who had scarlet fever at the age of ten, a definite attack of abdominal pain with vomiting at fifteen, and at eighteen, twenty, thirty-two, and forty-five similar attacks with hematemesis and occasional melena. Chronic disease of the appendix and gall-bladder was diagnosed. Operation revealed an appendix held down by a band and one stone in the gall-bladder; appendicectomy and cholecystostomy were done. These authors do not agree with Woolsey, who estimated gastric hemorrhage as occurring in 2 per cent of appendicitis, and 5 per cent of gall-bladder infection, believing this percentage too high. Bleeding from the bowel in these circumstances must not be confused with the postoperative hemorrhage from failure to ligate the appendical vessels or the slipping of a ligature after it was tied. This constitutes an active emergency; in many cases the abdomen must be reopened and the bleeding vessel secured.

Other types of postoperative hemorrhage following appendix operations are not easily explained. A few days, say three to ten days, after removal of the appendix, a sudden severe hemorrhage takes place; this may be repeated once or twice and then definitely cease. In others it may be fatal. A boy of nine years operated on by Kümmel for acute appendicitis had a severe hemorrhage five days afterward with frequent stools and died on the eighth day. The abdominal cavity showed no changes, but an ulcer, 7 by 11 centimeters, was found in the duodenum, with erosion of the pancreatico-duodenal artery. The origin of the ulcer was attributed to embolism. Phifer performed an appendicectomy on a young girl who showed symptoms of bleeding and passed blood by the bowel on the second day after operation. The abdomen was opened and the appendix stump found in proper condition. Bleeding stopped on the fifth day. Phifer judged the hemorrhage to be from thrombosis and embolism in the intestinal walls, inducing ulceration. He also cites the following sources of direct bleeding after appendicectomy: the superficial abdominal vessels, the deep epigastric and external iliac arteries and veins, the meso-appendix, the appendix stump, the walls of the abscess cavity, the intestinal canal.

Genito-urinary Complications.—*Hematuria.*—In addition to the fact that associated lesions of the kidney, ureters, and bladder may coëxist with any type of appendicitis, there are certain complicating symptoms of these affections which may occur to annoy the observer. Chief of these is hematuria. It is not uncommonly seen in both acute and chronic appendicitis. Its significance in diagnosis has already been discussed. As a complication either during the attack, in the course of a chronic case or after operation it should receive due attention. There is perhaps general agreement with Kümmel, whose experience led him to observe that when hematuria occurs during the acute stage the prognosis is unfavorable. He had a case in a child of three years, with severe renal hemorrhage, which had masked the diagnosis of appendicitis. Operation revealed a gangrenous, perforated appendix, with diffuse peritonitis, ending in the death of the child. Similar cases reported in the literature showed severe acute hemorrhagic nephritis at autopsy. Occasionally, as Kümmel observes, hematuria may occur later, after two or three weeks. A youth of nineteen was admitted with a history of painful micturition and bloody urine for five years. He developed symptoms of appendicitis. Operation showed an ulcerated appendix, adherent to the adjacent parts and containing a fecal stone. After operation the patient's urine was free from blood and all pains ceased; he was discharged cured. Three weeks later he returned complaining of pain in the left epigastrium and frequent vomiting. Urine contained many blood-cells, blood-casts and epithelium. General treatment did not improve his condition. Examination of both kidneys showed lowered function, and hemorrhagic nephritis. Decapsulation was performed on both kidneys, with complete cure.

There have been reported several cases of appendicitis, between twenty and forty years of age, having typical renal colic and hemorrhage, which were cured by removal of the appendix. Another case of Kümmel's: A girl of twenty was seized suddenly with severe pain in the right renal region with passage of very bloody urine and high temperature. At the same time McBurney's point was very tender with rigidity of the rectus muscle. The diagnosis pointed more to an acute appendicitis, though the right kidney was very tender on pressure and it was thought that the hemorrhage from the kidney was a secondary, infectious glomerulonephritis. The greatly inflamed appendix was removed. Bleeding from the right pyelitis continued for a while, but the patient made a complete recovery.

Anschütz regards acute nephritis in patients with appendicitis as an indication for removal of the appendix. The kidney inflammation is usually of the hemorrhagic type and subsides very quickly.

A case of von Becke's is enlightening. The right kidney was removed for persistent hematuria confined to that side. Pain, swelling, and fever continued as before. The gall-bladder was first explored and found normal; to it the tip of the appendix was adherent. The appendix was removed, a few more adhesions were released, a complete cure resulted. Right hematuria, says von Becke, should always suggest a possible appendicitis.

A striking example is that recorded by Ashhurst and Woodson in the person of a physician, twenty-six years of age, who suffered from irritability of the bladder and frequency of urination for two years, accompanied by indigestion and flatulence. There were attacks of burning pain in the urethra with scanty micturition and several hours later pain in the penis and right testis. The suffering became more and more severe. He was removed to the hospital in a state of shock—profuse cold sweats, restlessness, subnormal temperature. There was no spasm of the recti muscles, only very slight tenderness on deep pressure in the right lower abdomen, and the white blood-count was 9,800. The urine was loaded with red blood-cells. After an enema there was a sudden cessation of pain. The x-ray showed shadows very like stones on the right side. Six days after being discharged with relief, the patient was readmitted with acute abdominal pain and vomiting—a different pain, epigastric entirely; but the next morning it located in the right abdominal region and tenderness developed over McBurney's point. At operation the appendix, gangrenous at the tip, was adherent in the right lumbar region, contained two coproliths and fecal pus under tension.

Another impressive instance was published by Tormey. A farmer, aged fifty-two, suffered attacks of pain in the right side, radiating to the head of the penis and the scrotum, requiring large doses of morphia. There was blood in the urine, a leukocytosis of 10,400, no abdominal signs, negative x-ray. The cystoscope showed some indefinite obstruction about 4 inches up the right ureter, but urine came from the kidney. Tenderness on deep pressure remained after the cystoscopy. Incision was made for the removal of a ureteral stone, but none was found; a hard mass was felt lying over the pelvic brim. The peritoneum was opened and a perforated gangrenous appendix was taken out.

A case exhibiting hematuria was found by Ascoli to be due to compression of the right ureter by the exudate from appendicitis. His case reminded me very forcibly of one seen by me before the days of perfected x-ray and cystoscopic technic. A young man had the typical signs of stone in the right kidney—colics, reflected pain, blood and pus in the urine. So definite did the diagnosis seem that a right lumbar incision was made and the kidney explored with negative results. While manipulating the kidney an intraperitoneal mass was felt. The incision in the loin was closed, the abdomen was opened through the right rectus muscle exposing a subacutely perforated appendix attached to, and apparently seeping into, the right ureter. The appendix was removed and a gauze strip passed down to the site of the adherent structure. The patient recovered from the operation and remained well. One more case of this type occurred in my practice, as well as another in which a very high and posterior inflamed appendix was found tightly glued to the peritoneum over the kidney, evidently the cause of hematuria complicating attacks of right-sided pain.

We cannot escape from the conclusion that, while contact may be the immediate source of bloody urine in these instances, intoxication and infection play a large part. As a rule, if only blood is found in the urine, one would be justified in considering a contiguity of structure or a toxic irritability, but when, as frequently happens, pyuria is also present, an infection exists, which in the absence of a genito-urinary lesion must be assumed to be of the hematogenous type from the inflamed appendix. For instance, it seems on critical analysis that the urine in von Becke's case (*vide supra*) was purulent and furnished no reliable guide. But the evidence appears conclusive when removal of the appendix clears up the disease and its complications.

The question, What causes the hematuria? will continue to come up in each case. It opens a wide field for discussion in general. Is the bleeding due to direct irritation or to toxi-infection through the blood stream? Ashhurst and Woodson believe the former more likely. Their reported case seemed to bear out this theory. In other types the principle of systemic toxemia would better apply.

Such is the proposition of Giuliani who considers hematuria in the course of appendicitis as being caused by colon bacillus infection of the renal pelvis and pleads for a complete bacteriologic study of the urine in these cases. He does not believe the common cause to be a "renal reflex congestion" as explained by previous writers. A case in point led to his conclusion. Following a well-timed operation on a girl of seven, at which was removed an appendix, gangrenous at the tip, and a drain introduced, the patient developed on the second night rather abundant hematuria. For two days the urine remained red. On the fourth day intestinal obstruction ensued, necessitating an enterostomy upon a loop of small intestine on the right; three days later a second enterostomy was done upon a similar loop on the left; the patient was relieved. These emergencies precluded for the time being any attention to the urinary complication. Fifty days later an accession of the hematuria took place, followed by a febrile period two weeks in duration. During this time the urine was systematically examined morning and night and showed each time (after cessation of the macroscopic hematuria) some red globules in the centrifuged sediment, a few white globules and numerous colon bacilli. For greater accuracy the vulva was minutely sterilized before micturition and the urine collected in a sterile receptacle. All the examinations showed the same microbes.

Gottlieb's conclusions are as follows: Hematuria in appendicitis is rare; in not all of the reported cases was the hematuria proved to be due to the appendicitis; an etiological hematuria in appendicitis is not clear; in cases of hematuria of obscure origin appendicitis must be considered; in doubtful cases the appendix should be removed. The source of the bleeding may be one kidney, the right ureter or the bladder, and it must be determined whether the cause be nephritis, thrombosis and embolism, direct extension of infection or reflex congestion.

Laroche regards hematuria as rare in chronic appendicitis. In such cases he finds the appendix generally retrocecal, often adherent to the kidney or to the ureter. Methodical examination is essential. He finds it difficult to explain the presence of albumin in renal and vesical hematuria. The reflex origin is not satisfactory. Some authors think that the hemorrhage is provoked by renal infection due to microscopic particles carried from the appendix by way of the portal vein and vena cava. In nephritis and latent cystitis the presence of albumin, casts and leukocytes is readily explained. Inflammation of the kidney, ureter and bladder is induced by infection with the colon bacillus, whether produced by local congestion or by contiguity of the inflamed appendix. Laroche cites one case, a boy of fifteen, with chronic appendicitis, whose symptoms were of vesical origin. For nineteen months he had constant desire to urinate, day and night, and often voided urine involuntarily. The urine was normal. He had some digestive disturbances. Abdominal and rectal palpation and x-ray examination led to the diagnosis of diseased appendix of the pelvic variety. Operation showed the appendix situated low down against the bladder, but not adherent. All vesical trouble disappeared completely after its removal.

Kreutzmann's opinion is that in acute appendicitis a general toxemia occurs, involving the kidney; while in chronic appendicitis a localized reaction takes place at the point where the appendix is adherent to the ureter.

Appendicular Kidney.—Toxic appendicular nephritis was referred to by Dieulafoy as the appendicular kidney. In its simplest form it exhibits a single sign—albuminuria. Most all severe appendicitis cases have a certain amount of albumin in the urine along with other toxic signs; it gradually disappears after recovery from the operation. In appendicular nephritis, as described by Dieulafoy, there is usually no edema and the albumin is scanty, compared to other forms of nephritis. Often jaundice is present when the liver is involved. The appendicular liver can result directly through portal vein infection; the appendicular kidney comes by a roundabout route, so that the toxic nephritis is common, whereas the infective variety is very rare.

Four cases of acute appendicitis associated with active kidney infections were related by Harbin: in all of them the diagnosis was doubtful until the appendix signs were urgent. He notes what is very true, *viz.*, that we are apt to "discard the diagnosis of appendicitis upon the discovery of characteristic findings of renal infection." Harbin believes that there are metastatic infections of the appendix and kidneys that result from a common focus; that caution should be taken before excluding acute appendicitis in the presence of renal infection; that in cases of doubt without fulminant symptoms one can deliberate, employing frequent leukocyte counts.

Other Complications.—In his study of genito-urinary symptoms in acute appendicitis Cope comments first upon frequency of micturition. He finds this rather common and usually due to direct irritation of the bladder by the periappendicular inflammation. He further explains that, when the appendix is in the pelvis, there is usually no rigidity of the abdominal wall, and the combination of hypogastric pain, lax abdomen and frequency of micturition might mislead one into thinking the bladder was the source of trouble. Retention of urine is very rare, except in patients who have received large doses of morphin.

Pain on urination is quite frequent, regardless of the position of the appendix, for it may be near the kidney, ureter or bladder. Tenderness in the right erector-costal angle, a constant sign in right kidney disease, may occasionally be elicited in appendicitis, owing to a hyperesthesia of the posterior area supplied by the tenth dorsal nerve, which also supplies the appendix.

Testicular symptoms, which are the especial concern of Cope, have been noticed by other writers only in a casual way. Pain or discomfort in the testicle may be observed in at least 5 per cent of the cases. According to

Cope, it is not often as severe as the general abdominal pain and the patient may not complain of it unless directly questioned. It is either a dull aching or a sharp shooting. It may be either in the right or left testicle, or in both. It is due to the appendical disease and not dependent on any disease of the genito-urinary system. Though the pain is easily associated with perforation of the appendix, it may occur without perforation. It may precede the onset of the abdominal pain by at least an hour or two, though this is unusual. The duration may be short or as long as two days.

Undescended Testicle.—Undescended testicle as a complication of acute appendicitis was observed by Herzig in a boy of twelve years. A subject of bilateral cryptorchidism, the patient was seen shortly after his second attack, in six weeks, of "cramps," previously designated as "incarceration of right testicle." The left testis was swollen and caught in the canal; there was marked rigidity of the entire abdomen, boardlike in the right lower quadrant; Rovsing's sign was positive and Reder's sign marked; leukopenia was present with a high polymorphonuclear count and albuminuria; nausea and vomiting were absent. On operation it was found that the testicle and cord were strangulated from pressure, owing to the rigidity of the abdomen. The gland and its structures were freed and fixed in the scrotum. Then followed an exploratory laparotomy. Much free pus escaped on penetrating the peritoneal cavity, and an adherent, sloughing, ruptured, retrocecal appendix was identified, but left undisturbed. A cigarette drain and a soft rubber glove were carried down to the appendix and into the pelvis for drainage. The process was uneventful until the fourteenth day, when the temperature rose to 101° F., with a leukocyte count of 22,000. There was abdominal distention, the wound was draining very little and no results were obtained from enemas. Next day the patient was running a septic temperature. On probing the wound, with the gloved finger, pus welled up and a cigarette drain was inserted. On the seventeenth day, the patient had a scarlet rash on the neck, chest, back and limbs, and was isolated. Six days later the drain was removed. He was discharged healed and went home twenty-eight days after the operation. A congenital anomaly of this nature is of importance, because both by location and general symptomatology it afforded sources of error and opportunity for judgment.

The finding of freakish abnormalities in patients seized with acute appendicitis seldom is of great significance. One instance, reported by Yates, is notable for its many and peculiar malformations. A girl of eight operated upon without incident forty-eight hours after the onset of an appendical attack showed the following anomalies: The umbilicus about 9 centimeters below its normal location; diastasis of the recti muscles; apparent exstrophy of the bladder beneath the skin; nonunion of the pelvic bones; irregular and undefined external genitals, except the clitoris; absence of the vagina.

It is well to notice and record such findings as these whenever they appear; for they might be concerned with possible anatomical disarrangements in the abdomen, in some way affecting the conduct of the case at the time or in its after treatment.

Movable Kidney.—Movable kidney, referred to in the chapter on Diagnosis and there mentioned as a not infrequent accompaniment of appendicitis, may serve as a complicating disorder both in the acute and chronic varieties. In the former it is of no concern one way or the other after its presence is confirmed; in the latter one may well question whether or not the displaced kidney is the cause of the syndrome with or without a real chronic appendicitis. Edebohls sincerely believed and taught that a movable kidney may not only simulate an inflamed appendix, but even cause a true appendicitis by pressure of the loose kidney upon the return circulation of the appendix. This shows the great care needed in obtaining the history of supposed appendical attacks and of being mindful of kidney complications. Few authorities hold fast to the view of Edebohls. But unquestionably movable kidney is a genuine factor in appendicitis.

Not all the figures agree upon the frequency of the association. A report by Silvan reveals that in 28,000 operative cases in Venice hospitals over a period of twenty-eight years there were 893 appendix cases and 195 of movable kidney; but that these two conditions were combined only in fifty-one instances. Apropos of the coexistence of appendicitis and floating kidney, and the question of operating for both conditions (albeit nephrorrhaphies are now seldom practiced) it was maintained by Edebohls, and with a certain justification, that it was easily feasible to remove the appendix through the lumbar incision made for anchoring the kidney.

Krafft operated on a woman of thirty-one years for traumatic movable kidney (nephropexy), which had involved the appendix. One month previously she fell violently and injured the right lumbar region as noted by extensive ecchymoses of the area. Displaced kidney was shown by x-ray and operation revealed an inflamed appendix, which was removed.

Inguinal Adenitis.—Inguinal adenitis of appendical origin was seen by Chifoliau and Humbert in a woman of sixty-six years—a suppurating gland in the right inguinal region and a tumefaction in the right iliac fossa. It was accounted for by infection spreading along the lymphatics, reversal of current. I should be disposed to look further and in a different direction for infection of the inguinal glands, no matter what the age or social status of the patient. Possibility of a return lymph flow, however, is freely admitted. A case reported by Ondan seems to prove the direct relation. A soldier, aged twenty-four, had malaise and vague abdominal pains ten days previously. He kept at work and partook of his meals without interruption. He had noticed a swelling in the right groin several days. On the tenth day acute symptoms set in; diagnosed as appendicitis; operation was done at once. A long, perforated, gangrenous appendix was found, with pus extending along the inguinal canal and producing the bubo in the groin. He went through a severe peritonitis but recovered.

Boidin and De Gennes have previously recorded in the same publication a very complicated case, an inguinal adenitis of appendicular origin resembling bubonic plague. The patient, a man forty years old, was admitted with a diagnosis of strangulated inguinal hernia. The onset ten days previous began with malaise, and anorexia; there were no abdominal symptoms such as pain, nausea, vomiting—only slight constipation. Some fever and pulmonary signs, dyspnea, cough and mucous expectoration ensued. A few days later a painful tumefaction appeared in the right inguinal region, becoming tense and inflamed. Puncture yielded a slightly sero-bloody fluid. The general condition became rapidly worse; rapid difficult breathing and slight albuminuria came on with a dry tongue, but no vomiting or diarrhea, abdomen not rigid. The adenitis became more severe, and, bubonic pest being suspected, inoculations of white rats and guinea-pigs were made, with negative results. The bubo was incised and 200 grams of fetid green pus evacuated. The patient died from exhaustion and sepsis, Autopsy revealed an appendix 27 centimeters long, free from abdominal adhesions. It occupied the hernial tract; its extremity was inflamed and gangrenous and communicating with a bubonic sac. There were also several small aortic vegetations, bronchopneumonic foci and a large suppurating infarct occupying the entire superior pole of the right kidney.

Hernia.—This brings us to consider hernia in its relation to appendicitis. Every surgeon comes upon hernia as a complication of appendicitis—which is another way of saying that a patient with a hernia may have a diseased appendix, originating either before or after the appearance of the rupture. And appendicitis may complicate the hernia by its simultaneous occurrence in the acute stage or by its appearance within its rings or sac. As inguinal hernia is the most common variety, so it is the type most frequently associated with the appendix, particularly and naturally on the right side. Ordinarily when a subject of any sort of hernia develops appendicitis of any type the latter is of chief importance, unless the former be strangulated. In such an instance immediate attention to the hernia becomes imperative and then consideration to the appendical affection may be given. When both conditions are of long standing with no acute manifestations, it might well be questioned which one of the two is complicating the other. Equal and simultaneous attention may be paid to them. If a hernia should occur in a patient already the subject of appendicitis, acute or chronic, the complicating elements should be judged in the light of the individual circumstances.

Inclusion of the appendix in a hernial sac is not common. Generally along with the appendix are found the cecum, omentum or small intestine, but occasionally the appendix alone is seen. The former is apt to occur in patients past middle life, the latter in young children. Inguinal hernia of the appendix is the most frequent form, constituting, according to Watson, about 55 per cent of all cases, while 40 per cent are femoral, 4 per cent umbilical and the remaining 1 per cent ventral, diaphragmatic and obturator.

The presence of a healthy appendix in the sac of a hernia is hardly ever foretold previous to operation. It might be suspected if there was undue pain in an irreducible hernia, but even then the appendix must be inflamed to be sensitive and it would be difficult to distinguish this from adhesion of any other portion of the intestine. An acutely inflamed appendix, either with the cecum or lying alone in the sac, has often been prophesied before operation. At most, however, the slipping of an appendix into the hernia is purely an accident and its diagnosis a matter of chance.

Direct acute strangulation of the appendix is rare. I have observed it in two cases, in a femoral hernia in an old man of seventy-five years, and in an inguinal hernia in a child of five years. Each sac contained the isolated appendix, dark-colored and completely constricted about the middle, where it was enlarged in the ring. Hernial appendicitis, or inflammation of the appendix already in the sac of a hernia (where it is increasingly liable to injury and pressure), is often confused with strangulation of a hernia containing an uninvolved appendix. Watson found in the acute forms some abdominal distention and tenderness, but no rigidity; occasionally referred scrotal pain in the inguinal hernia or, in the femoral variety, knee or hip-joint pain; a moderate run of temperature because of early closure of the sac.

Otto reports operations upon six cases of appendicitis in the hernial sac: three women with femoral hernia, two men and one boy (two years of age) with inguinal. He found the clinical symptoms so blended that it was almost impossible to differentiate between primary appendicitis in a hernial sac and primary incarceration of the appendix. Appendicitis, he thinks, may be suspected when a hernia is accompanied by subjective symptoms of any kind, especially when it becomes irreducible, hardened, and increased in volume. Intestinal and general symptoms gave him no points for correct diagnosis. Occasionally inflammatory appearances, such as redness of the skin and possible later fluctuation may be diagnostic. Phlegmon of a right hernial sac points to appendicitis within. Exception to this may be seen in cases where pus is found at the hernial opening, but coming from an intra-abdominal appendix, the inflammation extending into the sac. In untreated hernial appendicitis not rarely a fistula is formed from which occasionally fecal concretions escape; this makes the diagnosis probable, especially when the fistula is localized in the femoral or inguinal canal. If, however, the abscess extends further down and breaks into the scrotum, the correct diagnosis is again difficult. A hydrocele may become purulent and complicate hernial appendicitis, as witnessed by Otto in one case.

Left Inguinal Hernia.—Acute appendicitis in a left inguinal hernia is extremely rare. One such instance came under my observation, unexpectedly, in a case diagnosed as incarcerated hernia.

A double inguinal hernia presented some confusion in a case reported by Wildman. A male fifty-five years of age gave the history of recurring attacks of pain and swelling in both inguinal regions, especially the left, for four years. The day prior to operation the pain was very severe on the left side. Examination showed marked swelling on both sides; the one on the right was readily reduced by taxis; the left was diagnosed as strangulated inguinal hernia. On operation a tense elastic tumor was explored, embedded in a dense mass of fatty tissue. Lying upon the posterior wall of the sac was an acutely inflamed appendix, 6 inches long, bound down by a mass of adhesions. Attached to the upper and inner surface of the neck of the sac was the cecum.

Bradburn opened up an incarcerated right inguinal hernia, with inflammatory signs, and found a considerable quantity of pus in the sac, besides the following pathology: a ruptured appendix with gangrenous mesenteriolum, as the sole contents of the hernia, and the cecum plastered against the neck of the sac on the abdominal side, acting as a plug to protect the cavity. No attempt was made to close the hernia opening—a wise decision.

Femoral Hernia.—Appendicitis in a femoral hernia is less common than in the inguinal variety. It is apt to be slighted in the diagnosis of swelling in that region. In the instance referred to above, observed by me in 1896, incision was made over the saphenous swelling on the belief that it was an inflamed lymph gland. Similar cases have been recorded.

One by Hodgson was interesting. A woman, seventy years old, was admitted with intestinal obstruction of four days' duration, presenting also a walnut-sized swelling in the femoral region connected with a discharging sinus. Eight months previous the swelling came after a severe attack of abdominal pain and burst, running pus, and then had healed; diagnosis, intestinal obstruction (due probably to cancer of the colon) and suppurating lymphatic gland in the groin. Abdominal operation resulted in finding a right femoral hernia of the small intestine, a knuckle of which was strangulated, and the appendix deeply adherent to the wall of the canal. Evidently here the appendix, sometime in the hernial sac, had become inflamed, had perforated and formed an abscess which had ruptured externally; the sac had remained open, allowing the intestine to be strangulated.

An unusual occurrence was reported by Zoepffel—a retrocecal hernia with beginning incarceration caused by perforating appendicitis. An eighteen-year-old boy was operated on for peritonitis due to perforated appendicitis. A large sac containing all of the small bowel was found behind the cecum; the colon was the only intraperitoneal portion of the intestine. The loops of small intestine were collapsed and cyanotic, while the part lying in the opening of the sac was inflamed. This inflammatory area was due to the inflamed appendix and was producing strangulation of the gut by narrowing the entrance of the sac. Undoubtedly the retrocecal hernia was a congenital malformation.

Right Inguinal Hernia Following Appendicectomy.—Inguinal hernia on the right side following appendicectomy has been the subject of discussion in recent years. A constantly increasing number of hernias following operations on the appendix, even in the clear cases without drainage, has drawn attention to their possible causes and prevention. In 1922 Oudard and Jean studied nine cases of their own, occurring in adult males and showing an average time incidence of thirteen months following the operations. In each case the abdominal walls were attenuated, the external ring was enlarged, the sac wall was thin, and invariably the content of the hernia was chronically inflamed omentum, which was adherent to the sac. These adhesions, say the observers, occurred at the time of the appendical attack or just after the operation, and constituted probably the primary causative factor in the development of the hernia. A secondary factor is injury to the abdominal muscles or their nerve supply. No reference is made by Oudard and Jean to the kind of incision as playing any specific part in the incidence of this type of hernia.

The matter of postoperative incisional hernia will not be discussed at this time. More properly it would come under methods of operating and aftercare.

Pregnancy.—In the combination of a diseased vermiform appendix and the pregnant state there exists a double-acting relation. The appendicitis may complicate pregnancy and pregnancy may complicate appendicitis. The most vital association, of course, is the occurrence of acute appendicitis in the pregnant patient. But pregnancy taking place in a woman already affected with chronic appendicitis presents a problem of solution either as a basis for the future or in the fear of an acute lighting up at any moment. Gestation is known to provoke symptoms in the pathological appendix, but does not initiate disease in a healthy appendix. Appendicitis occurring as an acute emergency during gestation is more often seen in the earlier months; it has been known to appear in the throes of labor; not uncommonly it shows a predilection for the puerperium.

As to frequency reports differ. In 1911 south European records afforded 485 cases, with the statement that 1 per cent of all pregnant women have appendicitis and that 2½ per cent of all women having appendicitis are pregnant. Previously eleven cases had been collected from American literature in 1897 and thirty-one cases from northern Europe in 1902. Up to 1910 about five hundred cases altogether had been observed. Since that time the literature has abounded with them. Most authors hold that appendicitis in pregnancy is much more frequent than is generally supposed.

In 1921 De Lee thought that acute appendicitis was met with in pregnant women with probably not more than its normal frequency in nonpregnant women. During thirty years of practice he encountered only four cases of appendicitis in very late pregnancy. It is said, however, that reports from large obstetrical clinics in other parts of the world indicate a greater frequency in late pregnancy than De Lee gives. The large majority (80 per cent estimated), however, are seen before the sixth month.

Acute appendicitis during active labor is very rare. Grattan's case, reported in 1919, was, as far as he could find, the very first one on record for ten years previously. It was an initial attack occurring in and operated upon during the first stage of full-term labor in a primipara and the appendix was gangrenous with beginning perforation. A half hour after closure of the incision around the drain, the patient exhibited regular labor pains, was delivered with the assistance of low forceps about nine hours later, went through a stormy postoperative experience with cardiac and renal symptoms and jaundice (adjudged to be the result of appendical toxemia), and made a complete recovery. The baby lived about seven hours after delivery, dying with toxic signs, also attributed to the purulent appendicitis.

A more recent case in the practice of Barber and Miller turned out favorably. Acute appendicitis, not severe but definite, occurred with the onset of labor. Appendicectomy was performed and under the anesthetic an immediate breech extraction was successfully accomplished. Several writers have described cases operated upon within a few days of labor at full term.

The mortality attending acute appendicitis in pregnancy has been described, even up to later years, as "frightful," "terrific." In 495 cases it was found that of the suppurative types the death rate was 29.7 per cent in the operative and 80 per cent in the nonoperative cases; while of the nonsuppurative cases it was 1.1 per cent in the operative cases, and 4 per cent in the nonoperative. The record of abortion or death of the fetus was 40 per cent. According to Anderson and others the high mortality is due not to the fact that the patient is pregnant, but to the failure to recognize the condition early, thereby delaying surgical treatment.

Pregnancy exerts no untoward influence upon the normal appendix. It can, and frequently does, however, aggravate existing chronic inflammatory conditions or appendices that deviate from the normal in length, mobility, shape and location. Chronic appendicitis with numerous firm adhesions may interfere mechanically with the enlargement of the uterus, with uterine contractions of labor, cause subinvolution, excite oöphoritis, produce abortion, or give rise to twisting of the adjacent tube leading to extra-uterine pregnancy, etc. Oftentimes there coexists with a chronically inflamed appendix a large right cystic ovary with more or less salpingitis.

In a case on my service I found in a woman six months' pregnant, a right ovarian cyst with torsion of its pedicle (four times to the right) and the appendix plastered firmly around it, being involved in the twist.

De Lee stands by the position of general surgeons whose opinion he values that "the pregnant state aggravates the dangers of appendicitis manyfold," owing to many complicating factors: more rapid gangrene and perforation, more violent and widespread appendicitis, weaker reaction, less likelihood of protective adhesions, increased vascularity, greater danger of thrombosis and embolism, less adequate drainage, and earlier occurrence of intestinal obstruction. From his own experience De Lee finds a higher mortality in pregnant cases over the nonpregnant, but the rate is far greater after the seventh month, reaching up to 40 per cent.

Whatever may have been the former death rate, it is fair to say that the present percentage of recoveries is increasing. It is difficult to understand the reason for losing so large a number of appendicitis cases in pregnant women, except on the assumption of failure to suspect the disease or lack of moral courage to take time by the forelock. In my view the condition is dangerous only as the infected appendix itself is dangerous; the pregnancy adds but little to the risk. And the pregnant state, so far from being a contraindication, is even a more urgent indication for prompt operative interference.

I join with Anderson in saying that the diagnosis is often overlooked because the pathognomonic symptoms are blurred. Both patient and physician are apt to regard all symptoms referable to the abdomen as more or less minor disturbances of pregnancy. Examination by palpation is not always satisfactory, especially in the later months, because the ascending uterus covers the ileocecal region. At times it may be extremely difficult to recognize appendicitis in the later months of pregnancy, and this may account for the increased death rate at that stage; for the mortality of appendicitis during pregnancy is the mortality of delay. On the contrary one should not be too quick to interfere until a proper elimination of other conditions has been accomplished. Pregnancy itself gives painful contractions of the uterus and many pelvic and abdominal symptoms can be misconstrued. But once assured of the existence of acute appendicitis in pregnancy at any stage, operation for removal of the appendix is immediately indicated; and even in cases of doubt it would be better to operate than to neglect a possibly advancing inflammation. At or near term the problem assumes an obstetrical aspect, admitting of individual judgment. Usually it is best to adopt conservative measures following attention to the appendical pathology, depending on the urgency of the obstetric conditions. The gestation should not be interrupted, as this increases the mortality.

Reporting twelve cases which occurred in his clinic during one year, without a maternal death, or an abortion, Buford considers appendicitis the most important complication of pregnancy; found the recurrent type most common; pleads for immediate operation; condemns expectant treatment; believes the pregnant woman a safe risk, if her metabolism is good, and lays great store by a white blood-count over 12,000 in the diagnosis. Royston and Fisher found that acute appendicitis in pregnancy progresses very rapidly, tending to perforate early and to result nearly always in spreading peritonitis with little disposition to localize, or to form abscesses. The diagnosis is not difficult, unless the symptoms be marked by the discomforts of a stormy pregnancy. When acute abdominal signs suggest appendicitis, the complicating pregnancy is to be disregarded, for in the views of these authors, early operation in such cases is more urgent, if possible, than in the nonpregnant patient. They put ten cases on record.

Gore makes pertinent suggestions looking to prophylaxis. He believes that all women who have recurrent attacks of pelvic pain, dysmenorrhea, menstrual disturbances, and other pelvic disorders which cannot be definitely accounted for, should be considered as cases of appendicitis, and that all girls who have had attacks of appendicitis, and who are considering marriage, should be urged to have their appendices removed. Further he avows that removal of all diseased appendices before the occurrence of pregnancy, will reduce the mortality from 30 per cent to less than 2 per cent. It is his experience, also, that in cases which have excessive vomiting the appendix is very frequently diseased and that prompt removal will stop the vomiting at once.

I can corroborate this testimony. Three cases of hyperemesis gravidarum under suspicion as having recurrent exacerbations of chronic appendicitis were relieved of the vomiting immediately following removal of the appendices, all adherent and distorted. Furthermore two other patients who suffered such severe toxic vomiting during their first pregnancies that they had to be terminated, developed acute attacks of appendicitis within a year afterward and following removal of the appendix, each went through a subsequent gestation period to full term without abnormal vomiting or toxic signs.

If properly performed the operation for appendicitis in pregnancy does not produce abortion. As opposed to the practice of De Lee and others, who seem to use the pararectal incision as a rule, my preference in the pregnant woman, especially if at all advanced, is for the muscle-splitting incision of the McBurney character made well down in the right iliac region, avoiding the abdominal dome, and making it unnecessary to handle the uterus. By keeping low and to the outer side, the wall can be lifted centrally and the cecum brought up and away from the pregnant uterus. This is also the zone of safety, to be respected when suppuration and peritonitis are present, and drainage can be obtained more directly in a lateral direction. It is understood, however, that in diffusely infected cases, or obstruction types, prolonged incisions and extensive manipulations may become necessary. Here technical methods must be sacrificed for safety. In Gore's opinion the mortality in interval cases with a local anesthetic during pregnancy, as in uncomplicated cases, is practically nil. To him this is the secret of reducing the mortality in a condition where the death rate is far too high. If his experience is on a par with mine he must have found it rather trying to complete an appendicectomy under local anesthesia in a woman gone as far as six months in gestation.

Puerperium.—Like gall-bladder infection appendical disease is disposed to flare up during the puerperium. In my observation it is not so uncommon to find this complication within the six weeks following childbirth. I have more than a dozen instances on my record in which violently acute attacks with ruptured gangrenous appendices happened less than three weeks after labor; one of them occurred two days following delivery. Just as in the pregnant state there is in the puerperal stage a stronger urge for proper diagnosis and prompt treatment.

Ectopic Pregnancy.—Ectopic pregnancy may complicate appendicitis, and appendicitis of any type may occur in a patient who has an ectopic pregnancy. In truth the average incidence here might be the same as in intra-uterine gestation, since the latter is so much more overwhelmingly frequent. Many writers insist that a diseased appendix can and does cause ectopic pregnancies. Undoubtedly an inflamed adherent, pelvic appendix predisposes to abnormality of the tube and thus to the accident of tubal pregnancy on the right.

Numbers of cases, in which coincidence of the two conditions has been noted, are reported in the journals. Among them Landau's case should be mentioned. He operated on a woman of forty in whom simultaneous occurrence of the two acute abdominal conditions was apparently independent of each other. The question as to which was the primary lesion is obscure. Probably the ectopic gestation was of longer standing than the appendicitis, the symptoms being latent until the superimposed appendix inflammation hastened changes in the gestation sac, with the result that uterine bleeding began. The left tube appeared to be healthy, and, in accordance with the bilateral tendency of salpingo-oöphoritis, it is reasonable to assume, says Landau, that the right tube was free from any old-standing inflammation, and the infection of the appendix was not secondary to any tubal condition. The appendicitis was suppurative. There was difficulty in differentiation of the tender swelling in the right side of the pelvis associated with a mild pyrexia. The diagnosis lay between ectopic pregnancy, salpingo-oöphoritis, and appendicitis. The absence of nausea, vomiting and rigidity seemed to negative the diagnosis of appendicitis, although the pelvic type of appendix is often atypical in its signs and symptoms. The irregularity, intermittent temperature, and low situation of the pain were in favor of salpingo-oöphoritis, against this being the absence of purulent vaginal discharge and the unilateral condition present. The slight hypogastric distention which occurred indicated a pelvic peritonitis which might have been due to any of above conditions. The diagnosis of ectopic gestation was made in view of the activity of the breasts and the uterine bleeding.

In an instance recorded by Ruth there was no contiguity of structure, as the purulent appendix was high up in the abdomen. The correct preoperative diagnosis was helped very decidedly by the fact that the patient, aged twenty-three years, had had an apparent attack of appendicitis, accompanied by a slight menstrual flow, one month previous. She recovered in three days. On admission, the day of onset, she was in state of shock, with a temperature of 101° F., a leukocytosis of 17,000. Presumptive diagnosis of ruptured tubal pregnancy and acute appendicitis was made, based on the history and symptoms. Operation next morning showed rupture of the right fallopian tube from which sprang the placenta and cord and a 3-inch fetus. Pus in the upper abdomen came from the retrocecal appendix which was covered with a thin film of exudate. There seemed to be no attempt at limitation of the infection by adhesions of omentum or intestinal loops. The stump of the appendix was too thick and brittle to be ligated, but was inverted by suture.

Pelvic Diseases.—*Rupture of the ovary* with massive hemorrhage may complicate appendicitis and simulate tubal pregnancy. Indeed it may be impossible to differentiate these two conditions. Intra-abdominal hemorrhage from the ovary is very rare as contrasted with ruptured ectopic gestation, but there are reports of cases occurring along with acute appendicitis, resulting in difficult or erroneous diagnosis. Penn saw a young woman five hours after the onset of severe abdominal pain and persistent vomiting, with a temperature of 100° F., spasm in the right lower quadrant and a leukocytosis of 14,000. A diagnosis of acute appendicitis was made and immediate operation advised, but refused. Some hours later she was in almost complete shock, with great pain, headache, dizziness and a pulse of 140. When the abdomen was opened clots of fluid blood poured out from the pelvis leading to the right ovary which was normal in size, somewhat twisted on its stalk and presenting a ruptured graafian follicle. The appendix, highly injected and kinked, was removed along with the right tube and ovary. The amount of blood in the cavity was about 12 ounces. Apparently, said Penn, the hemorrhage was due to increased intra-abdominal pressure brought on by the persistent vomiting. The regular menstrual period set in on the day after operation.

Korach writes upon appendicitis and ovarian hemorrhages, reporting three cases in which a diagnosis of appendicitis was declared, but bleeding from a ruptured graafian follicle found to account for the symptoms. He quotes Hedde (1903) who had collected only thirteen cases in which hemorrhage from a ruptured corpus luteum was accompanied by alarming symptoms and Odematt (1919) who reported nine cases in more than nine hundred appendicectomies in which suspected appendix disease turned out to be bleeding from a ruptured corpus luteum. Korach is of the opinion that a positive differential diagnosis is almost impossible in these conditions. The blood-count may be helpful. He is correct in stating that generally the leukocyte count shows no change in the beginning of appendicitis, whereas hyperleukocytosis is found from the start in intra-abdominal hemorrhages, such as tubal rupture. Clinical observation and experimental results, he thinks, have shown that in certain cases of abdominal conditions a high leukocytosis is valuable to differentiate between inflammation and hemorrhage. In the absence of well-defined symptoms of infection, where the temperature and pulse are normal, or nearly normal, a high leukocyte curve indicated hemorrhage in the abdomen from some cause. In Korach's cases, however, the leukocyte counts were 8,500 and 10,000 which appears to discount its value in the differential diagnosis.

Two cases of chronic appendicitis in women, aged nineteen and twenty-four respectively, with *metrorrhagia* as the principal symptom, were reported by Hitzanides. In his judgment infection and congestion of the pelvic organs were responsible for both conditions.

It will not be expedient to go into further detail upon the pelvic complications of appendicitis. Their significance has been clearly set out in our discussion of the diagnosis. Any of the diseased conditions in the female pelvis which are to be differentiated from appendicitis will at times occur simultaneously, and therefore constitute a complication. If one feels reasonably sure of the diagnosis of appendicitis—acute or chronic—and at the same time fears possible pelvic complications, a bimanual examination will give the information upon which a proper judgment can be founded. In this way may be determined whether or not there is present a uterine fibroid, pyosalpinx, ovarian cyst, displacements and other less frequent maladies which could coexist with appendicitis.

The most common pelvic complication is salpingitis, at one stage or another. As has been succinctly stated by Nixon, the association of appendicitis and salpingitis is well known, but the sequence of cause and effect is not definitely settled. We only know that the tubes may become involved through extension of infection from the appendix, and vice versa. Furthermore, the tubes and the appendix may be simultaneously involved by separate and distinct diseases; this fact stresses the necessity of examining both these regions when called upon to operate for a lesion of one or the other. He cites the following authors: Petersen in a series of two hundred cases found that the appendix was normal in only 50 per cent and Gobritz found it normal in only 40 per cent, while Child in a study of 746 cases, covering all types of pathologic conditions of the pelvic organs, found a diseased appendix in 244, or 32.5 per cent. On the other hand, the danger of the appendix becoming involved through primary disease in the tubes is apparent from the observation that 66.66 per cent of cases of right salpingitis are complicated by appendicitis. The incident in left salpingitis is much lower.

Tuberculosis.—Appendicitis is rather to be regarded as a complication of tuberculosis. The latter is a disease of long duration often beginning near the age at which appendicitis is commonly found. A certain number of tuberculous subjects will be victims of appendicitis. No matter in what region of the body tuberculosis develops it may be complicated with or mistaken for appendicitis. We have explained that pulmonary tuberculosis and tuberculous peritonitis are often passed over and a diagnosis of appendicitis made, both in the acute and chronic types of each condition. So much the more confusion arises when tuberculous disease in the body is accompanied by appendicitis of any form. The tuberculous patient does have appendicitis, and as indicated in the previous chapter, it is not by any means always a tuberculous appendicitis; quite the reverse when the appendicitis is acute. In the presence of tuberculosis in any part of the body there is nothing to prevent other pathological processes from arising independently of that disease. When a patient with chronic pulmonary tuberculosis is also afflicted with a chronic appendicitis, the case becomes a surgical one, and should be managed just as if it were in any other patient—except in the matter of the anesthesia. Local anesthesia is preferable; if a general anesthetic is necessary nitrous oxid and oxygen are preferable; ether should be avoided. Griffith, of Asheville, North Carolina, who has had much experience in surgery upon tuberculous patients, uses local anesthesia whenever possible, but does not hesitate to employ ether, if needed. He has proved that "ether does practically no more harm to the tuberculous than to the nontuberculous lung." In nearly every instance these patients at once pick up, show greater resisting power and, if the appendix exhibited genuine pathology, rarely fail to go on to progressive improvement. In the event of a complicating acute attack, the amelioration is even more prompt and positive.

Armstrong endorses the removal of a diseased appendix from a tuberculous patient. He believes that appendicitis is often tuberculous, usually secondary to a focus in the lungs, rarely to a lesion in the intestines; that it is frequently followed by ill health culminating in active pulmonary disease; that a careful history and physical and x-ray examination of the chest be made in all chronic cases before operation; that convalescence be prolonged.

In a case of tuberculous peritonitis the appendix may be involved secondarily or it may be primary, the focal source. In either event it would partake of the tuberculous pathology. Quite rarely it may be of different bacteriological origin, and still more rarely it has been known to come in very acute form. Corvese has recently put on record an acute appendicitis occurring in the course of tuberculous peritonitis. He discovered only one previous case after a search going back twenty years. His case was that of a woman, aged twenty-one, who presented signs sufficient to admit of a tentative diagnosis of tuberculous peritonitis and who came down about six months later with acute abdominal symptoms. At operation the appendix was firmly adherent with a small walled-off abscess at the base, and found to be gangrenous, friable. A profuse purulent discharge, containing colon bacilli, kept up a while and a fistula persisted for over seven months. Anatomical tubercles and acute inflammatory infiltration were seen in the wall of the appendix.

Psoas Abscess.—A case of psoas abscess complicated by appendicitis has been reported by Gardner: A female aged twenty-two, married. Illness began five weeks before with dull pain in the right lower lumbar region, gradually getting worse and developing abdominal symptoms. Operation showed the appendix highly inflamed and bent upon itself. The cecum and part of the intestine were firmly adherent to the pelvic wall. Adhesions were broken up and the appendix removed. The abscess which was pointing 2½ inches external to the median line, was incised and 16 ounces of pus and blood of foul odor were removed. The patient recovered completely in seven weeks.

I have seen but one instance in which appendicitis occurred in a patient already having a right-sided psoas abscess. But I have encountered several in which the diagnosis between the two was exceedingly perplexing, and errors were made in both directions. The history of onset, the fixation of the right leg, the rigid spine, the absence of hyperleukocytosis distinguished the psoas abscess.

Silvestri discussed the relations between appendicitis and tuberculosis. Forty-seven patients, investigated by him, showed tuberculous foci in lungs, pleura, joints and the genital organs, occurring either simultaneously with, before or after attacks of appendicitis. The suggestion is made that the proportion would be increased if nonactive lesions were included and a plea voiced for extended observation of the matter.

Acute Infectious Diseases.—Acute appendicitis as a *secondary infection* during the course of acute infectious diseases is not very rare. Records of its occurrence in typhoid fever, scarlet fever, measles, diphtheria, pneumonia, influenza and other affections are put down in the literature. Most of these complicating diseases, of course, are seen in childhood, but the combination in adults is sufficiently frequent to require attention.

Typhoid Fever.—In typhoid fever, happily now becoming one of the rarer diseases in more civilized communities, the appendix is not uncommonly involved in the lymphoid infection due to the *Bacillus typhosus.* Even Peyer's patches have been found in the appendix. Such an affection has been referred to as "typhoid appendicitis"; but I regard the term as unfortunate, since it may lead to serious errors in diagnosis. A real appendicitis, caused by pus-producing organisms, can happen during the course of typhoid fever, and must be taken at its face value. The leukocyte count here is of paramount importance, especially if made at frequent intervals. No one should hold back in doubtful cases if there be a suspicion of acute purulent appendicitis, but operation should be done at once. It is better that surgical interference should be resorted to needlessly in typhoid fever patients than that one with peritonitis should die without an attempt to save him. Intestinal perforation of a typhoid ulcer should not be overlooked and appendicitis must not be confounded with it.

Scarlet Fever.—The incidence of acute appendicitis in scarlet fever is rare. And yet there are some striking instances reported in the literature. Dunham published a review of ten cases collected from the literature (1903--1919) and reported a case in a girl of five years in whom appendicitis developed two weeks after the onset of scarlet fever. Huebner (Jacobi, *Mod. Clin. Med.,* 1910, 692) states that some general purulent cases of peritonitis, occasionally preceded by appendicitis, are met with in scarlet fever. Many cases of so-called scarlatinal peritonitis come from an appendical source. McCollum and Place (Osler and McCrae, *Mod. Med.,* 1915, 1:878) reviewed a series of five thousand cases of scarlet fever in which peritonitis actually occurred in four. In these, the attack of scarlet fever was not especially severe.

Canelli says that appendicitis is a rare complication of scarlet fever, only fifteen cases appearing in the literature. He cites a fatal case in a child of two years.

Meyer cites the dicta of several authorities as to the great infrequency of appendicitis and scarlet fever in combination. The subject is an interesting one because of the supposed relationship between ordinary angina and the inflamed appendix. If the streptococcus is responsible for the association, he thinks, we should see it in scarlatina as well as simple streptococcus sore-throat. He has seen one scarlatina case and has obtained notes of another from a colleague. His own occurred in a typical lymphatic child, predisposed to inflammations and hyperplasia of lymphoid tissue. That the case was not a mere coincidence, or a lighting up of a latent appendicitis, was crucially shown by the fact that the boy had scarlatina twice, at an interval of about one year and that on each occasion he presented undoubted symptoms of appendicitis. In Meyer's case the double occurrence of scarlatina was no less a rarity than the appendicitis complication with which it should have a necessary relationship. He surmises as to whether appendicitis was not the primary lesion, but concludes that the child was a victim of a general sepsis and that the lesions were all metastatic. Cases of this type naturally do not assist in clearing up the border line between scarlatina and ordinary streptococcus infection.

Tice (*Syst. Med.*, 1920, 3:256) states, however, that appendicitis and peritonitis complicating scarlet fever is an accidental association and believes such observations are merely coincidences.

According to Thenebe, inflammation of the appendix is a rare accompaniment of scarlet fever. A definite toxemia is associated with scarlatinal infection. With the body concentrating its energy on combating this toxemia by antitoxin production, says Thenebe, it is easily conceivable that during this period of lowered resistance, the *Bacillus coli* or other organism diverging from its usual status in the gastro-intestinal tract, may then concentrate upon the appendix for its pathological activity. Further, he thinks there is also a possibility that in certain individuals the toxin absorbed during a scarlatinal infection may have more selective activity upon the appendix than upon the remaining gastro-intestinal tract, causing sufficient inflammation to make a fertile field for the growth of the *Bacillus coli* and other bacteria, thereby aggravating the pathological process. Within four months Thenebe saw 250 cases of scarlet fever, in four of which appendicitis was a complication. They were all operated upon and all recovered. Three were males and one was a female; their ages were twenty-six, seventeen, eighteen and seventeen years respectively. The first was an acute perforated appendicitis with secondary generalized purulent peritonitis, symptoms of which developed on the tenth day after the onset of the scarlatinal infection; the second was a simple acute appendicitis, definite physical signs of which were elicited during the routine physical examination; in the third the symptoms of acute appendicitis developed about one week after the onset of scarlet fever and symptoms, the inflammatory process becoming chronic; the fourth case was an acute gangrenous appendicitis with an acute typhlitis. The symptoms of appendicitis started one day after the development of scarlatinal symptoms.

A case reported by Newman was that of a boy of six years, admitted to the hospital with scarlet fever. On the fifth day abdominal symptoms set in and he was operated on two days later. A localized mass was found in the appendix region from which about 2 ounces of pus escaped. The appendix was found dipping over the brim of the pelvis, the distal end greatly distended, acutely inflamed with a perforation near the tip. Convalescence was delayed by an attack of measles.

Kelly cites an interesting example. A boy of eight years was taken ill with a severe attack of scarlet fever accompanied by abscess of the cervical glands. Three weeks later he was operated on for acute appendicitis. Turk, while attending the boy, contracted an angina supposed to be due to scarlet fever and fourteen days later he had an attack of appendicitis. Blood from Turk was injected into a rabbit and on its death, streptococci were obtained from the heart's blood.

Influenza.—The relation of influenza to appendicitis was mentioned in the chapters on Etiology and Diagnosis. Their association with each other is impressive. As influenza occurs only in wide-reaching epidemics one would look for it on those occasions as a complication of appendicitis and also expect to find a number of appendical attacks in influenza patients. What has been called "abdominal grippe" or "intestinal influenza" may mystify. Influenza is not a disease easy to identify; a process of exclusion must be practiced. And influenzal patients are not the best of subjects for operation. With the existence of a greater evil, however, no hesitation is to be countenanced. Surgeons have been through such experiences at times of universal incidence of this pandemic infection and have been called upon to use their keenest judgment and to exercise their highest sense of responsibility in deciding these questions.

Dubs calls attention to the abdominal symptoms in cases of grip, pneumonia and diaphragmatic pleurisy occurring during the epidemic of 1918–1919, and the difficulty of differentiating "catarrhal" appendicitis before operation. He gives the clinical history of six cases of true perforative and gangrenous appendicitis coincident with or following an attack of influenza.

Measles, Diphtheria, etc.—Similar observations to the above may apply to measles, diphtheria, and other infectious diseases, occurring largely in children. Medical literature seems not to be replete with reports of these complications of appendical inflammation as compared to those previously noted.

Simounin, observing the relationship between appendicitis and infective maladies, states that in seven cases appendicitis occurred following severe angina; four times, mumps; three, erysipelas; five, scarlet fever. He considers the streptococcus the more common agent and more active of all these forms of appendicitis from general infection.

Pneumonia.—Pneumonia, however, is frequently noted as an accompanying factor or as a sequela. Since most pneumonias also are seen in children, the subject will be referred to later. A typical example is a case reported by Pryde. The patient was a boy of three years. On the fourth day of an attack of typical pneumonia he was seized with symptoms of appendicitis. Operation was performed under A. C. E. mixture, "cologne water" being substituted for the alcohol. The points of interest are: The occurrence of an acute appendicitis in a child of three years; the presence of well-developed adhesions in a child of this age; the simultaneous onset of the pneumonia; the fact that the anesthetic was tolerated without untoward sign during the pneumonia; the appearance of the crisis on the thirteenth day following what was probably an added ether pneumonia.

Parotitis.—Parotitis in acute appendicitis may be met with. Its origin is metastatic and it is seen chiefly in the gangrenous or perforated appendix cases, Practically always the parotid gland infection goes on to suppuration, but it may stop short of this. Three cases are in my records, all developing parotid abscesses which were incised and drained; in one of the patients, a man fifty years old, both glands were infected. No other metastases developed. All three of the patients recovered.

A case reported by Gandevia and Wynne represents an instructive combination. A man admitted to the hospital with acute abdominal symptoms and parotitis, had been suffering from dysentery following an attack of epidemic influenza. Operation showed the whole of the abdominal contents in the region of the cecum adherent and matted together; a small quantity of foul-smelling pus was evacuated. The appendix was kinked at its center and perforated. Two days after operation the parotid abscess burst. He then grew worse and died the following day from general sepsis.

Sudler observed a case in which thirty-six hours following operation for appendicitis with abscess the right parotid region became tender, with a temperature of 105° F. (by rectum). Twelve hours later the left parotid gland swelled, but without such great height of the fever. Both glands returned to normal in eight and fourteen days respectively and no suppuration occurred. Sudler's review of the literature showed that "celiac parotitis" (Dyball) occurred on both sides in 30 per cent of the cases, that the appendix and the parotid gland seem susceptible to the same strain of cocci, and that hematogenous infection is the chief method of origin.

Among thirty-five cases of pyogenic infection of the parotid gland treated by Blair and Padgett three followed operations for appendicitis. One of the appendices was nonsuppurating. The *Staphylococcus aureus* was the infecting organism. In two of the three cases both parotids were infected.

Diarrhea and Dysentery.—The association of acute *diarrhea* and *dysentery* with appendicitis can be traced in some instances to mechanical causes, such as adhesions, kinks, irritation by scybala, indiscretions in diet, etc. In many cases the cause is toxic, originating in a distant focus or a generalized infection from the septic appendix. Whatever the source, one should keep in mind the not infrequent complication of loose bowels in appendicitis and steer away from the too rigid belief that appendix patients are uniformly constipated. As Short remarks, appendicitis accompanied by diarrhea is likely to give rise to difficulty in its recognition. To know that it may occur is a considerable safeguard. In simple enteritis with diarrhea, there are fever, pains and tenderness, but the tenderness is not constant in the appendix region. For our present interest the complication of appendicitis by diarrhea or dysentery may be a simple matter of coincidence or these bowel symptoms may be due to an infectious enteritis or a mechanical irritation; on the other hand the appendicitis may occur during the course of an intestinal upset resulting from other causes. The appendix itself is sometimes the irritative or infectious agent, for a number of cases with diarrhea or dysentery running on for a longer or shorter period are abruptly relieved by removal of the appendix. In such cases it is fair to conceive that the appendix lashes the intestine to constant action or harbors toxic material, which, when let loose at intervals into the cecum, induces too frequent stools.

Specific organisms may play a part here, primarily present either in the appendix or in the bowel. For example, Cignozzi makes a report of two cases aged twenty-four and twenty-six years respectively, suffering from acute amebic dysentery of several months' duration. They developed acute appendicitis with perforated appendix, circumscribed peritonitis and adhesions. All these recovered from the dysentery after removal of the appendix.

Sheldon and Heller are inclined to attribute the frequent intestinal discharges to dense adhesions at the terminal ileum. In about 1 per cent of all cases they say that the appendix is adherent at this point. The chief symptoms as described by these observers are: recurring attacks of pain in the lower right abdominal quadrant, either accompanied or followed by diarrhea; a tendency to diarrhea on the least provocation. There is usually a history of one or more disabling illnesses due to gastric upset, abdominal pain, some rise of temperature, followed by an interval of sensitiveness in the right iliac fossa and an associated mild dyspepsia.

In other words here is the symptomatology of appendicitis plus a mechanical irritation producing diarrhea as a complication. The following abstract of the further views of these authors may be given: The local pathology originates in the walls of the appendix and the serosa becomes involved early. In an effort to confine the infection to as small an area as possible nature throws out lymph and phagocytes. This exudate, under favorable conditions, causes adhesions to form with the ileum. The adhesions become vascularized and then more and more dense. This, in turn, produces an interference with the functions of both ileum and appendix, with the resulting symptoms. The mucosa of both the ileum and the appendix is affected late, or not at all. When affected, it is because of interference with function due to traction or stasis and interruption of the blood supply.

Hurst referred to a form of *pseudo-diarrhea,* in which small frequent stools are passed owing to the irritation of the rectum caused by a chronically inflamed appendix situated in the pelvis.

St. Jaques speaks of certain cases of appendicitis in which the toxicity induces acute infectious enteritis almost immediately from the onset and in which diarrhea appears as the dominant characteristic. Many French writers have laid stress on this particular aspect in cases of "hypertoxic appendicitis" where the acute enteritis took the leading part as a symptom, screening the pain at McBurney's point.

Chronic Constipation.—Chronic constipation, of course, is often associated with chronic appendicitis. Gastric hyperacidity and cecal adhesions largely may account for it. In such cases Okinezy believes that the appendix becomes infected by absorption of toxic microbes from the cecum and the colon. The attack comes on suddenly with all the acute symptoms. Operation usually shows a liquid effusion into the peritoneum, enlarged ganglia in the mesocolon and adhesions of pericolic membranes.

Rarer Complications of Appendicitis.—The less common types of disease complicating appendicitis may be enumerated for the purpose of shedding light upon their possible occurrence in any case. Illustrative instances are found throughout the periodic medical literature.

Dysmenorrhea.—Dysmenorrhea of appendicular origin is not infrequent in young girls. Acute exacerbation of a chronic appendicitis, especially if it occurs at or near the menstrual period, is due to congestion extending from the pelvis to the appendix situated low. In one instance I found the appendix fused to the right ovary in a young woman who had had painful periods only after the beginning of the appendical attack and who was entirely relieved after removal of the appendix.

Thyroid Disease.—The association of thyroid disease in chronic appendicitis has been referred to by Morris, who noted occasionally that after removal of chronically inflamed appendices thyroid imbalance disappeared.

Meningitis Serosa.—Meningitis serosa was observed during the course of gangrenous appendicitis by Steiger. A boy eight years of age was operated on for perforated appendix and peritonitis. On the third day he developed meningeal symptoms, which lasted five days. He was treated by lumbar puncture and recovered.

Tabes.—Acute appendicitis in tabes is the subject of a report by Krecke. A male aged forty-seven afflicted with tabes for several years was admitted with history of having had a severe chill two days previously and of being unconscious for several hours. He had repeated severe vomiting spells and diarrhea four or five days, then constipation three days. No pain whatever was expressed throughout the entire course of his illness. From the second day on there was high temperature alternating with chills. After several days the patient accidentally discovered a swelling in the right lower abdomen, about the size of a woman's fist, circumscribed, lying in the iliac fossa, of tense elastic consistence, with no pain or palpation. The leukocyte count was 19,000. Immediate operation showed the omentum adherent to the cecum and the parietal peritoneum fixed to the right side. On releasing the adhesions an abscess was found behind the cecum containing 100 c.c. pus. The appendix, which was in the posterior wall of the abscess and perforated at the tip, was removed. The postoperative course was bad; temperature did not fall, chills continued and the patient died from exhaustion.

This case of destructive appendicitis in Krecke's view is interesting in the absence of all subjective and objective symptoms. The absence of pain, he attributed to the tabes. He had no pain whatever referable to the appendix, but the signs of a general septic infection, and it was not until the twelfth day of the disease that a swelling was casually discovered, the nature of which was only made clear by operation. Cases are recorded in tabetic women who have gone through childbirth without labor pains being felt. No doubt the diseased area in the spinal cord, which gives off the nerve supply to the uterus, had been rendered senseless to impulses, and the simile may be applied to this case of appendicitis.

Hemophilia.—Hemophilia furnishes the interest in an article by Hipsley. His patient was a boy of twelve with a history of typical hemophilia, both personal and familial, who was operated on for a ruptured, gangrenous appendix. Knowing the history the operator secured several suitable donors in advance. For six days after operation the patient's condition was very grave, though the amount of hemorrhage at operation was rather less than usual. On the sixth day blood began to appear in the stools and on the day following the wound commenced to bleed. Transfusion of half a liter of blood was done with immediate improvement and hemorrhage ceased for seven days, then a recurrence; again transfusion of 200 c.c. and twenty-four hours later 450 c.c. He steadily improved and was discharged well at end of the sixth week.

Bilateral Necrosis of the Gluteal Muscles.—Bilateral necrosis of the gluteal muscles was the unfortunate complication in a case of Haberland's. A man of forty-seven years, obese, was operated on for ruptured appendix. Next day he complained of pains in the gluteal region, which was intensely reddened. Change of decubitus and water pillow gave no improvement. The incision around had healed in seven days. At this time there was sudden appearance of sugar in the urine. The glutei muscles now went on to a gangrenous condition; incisions, local and constitutional treatment—all failed and he died thirty-six days after operation.

Deavor's patient had the same misfortune, but got well. There developed a symmetrical gangrene of the nates, including the perineum, four weeks after removal of a gangrenous appendix, with drainage. A big gangrenous plug of tissue dropped out, leaving a huge cavity in the ischiorectal space. After a prolonged convalescence, recovery ensued with a good cosmetic result.

Cullen had a similar condition developing in and around the appendical incision—a progressively enlarging ulcer of the abdominal wall involving the skin and fat (Fig. 35). It followed upon drainage of an abscess situated about midway between the appendix and the gall-bladder region. Two days afterwards the incision looked red and inflamed; sixteen days later there was a wide ulcerated area; five and one-half weeks after operation, the incision was closed and the muscles united but the ulcer persisted and progressed until it was 12 inches across. Eventually skin-grafting was done; the area healed and the patient recovered, but only after multiple consultants had confessed never to have seen a similar case. The advance of the ulceration was checked finally by the cautery knife, applied well beyond the margin. *Streptococcus brevis* was the only organism found in the ulcer.

Embolism of the Brachial Artery.—Embolism of the brachial artery complicating acute appendicitis is the subject of a paper by Aschner, who reports one case in a chauffeur, thirty-four years old. Three days after operation at which was found and removed a perforated, gangrenous appendix lying in the pelvic position bathing in pus, the patient was seized with sudden pain in the right arm and hand, followed by numbness and restricted movements in the fingers, mottled appearance and cold condition of the hand, and absence of pulsation in the radial artery. Two hours later under local anesthesia the brachial artery was exposed and opened, a thrombus milked out and the incision in the vessel sutured with silk. In spite of a late infection of the brachial wound, interference with the nerve supply of the arm and loss of the thumb from gangrene, the result was recovery and restoration of function, thanks to intelligent after care. While the occurrence of pulmonary embolism after appendicectomy is a well-known complication, Aschner considers embolism of peripheral arteries exceedingly rare "for anatomical reasons." If the embolus comes from a vein in the abdominal wall, as is usual, he conceives that it might pass through the pulmonary circulation to lodge finally in a small terminal artery, but he inclined to the theory of a paradoxic embolism.

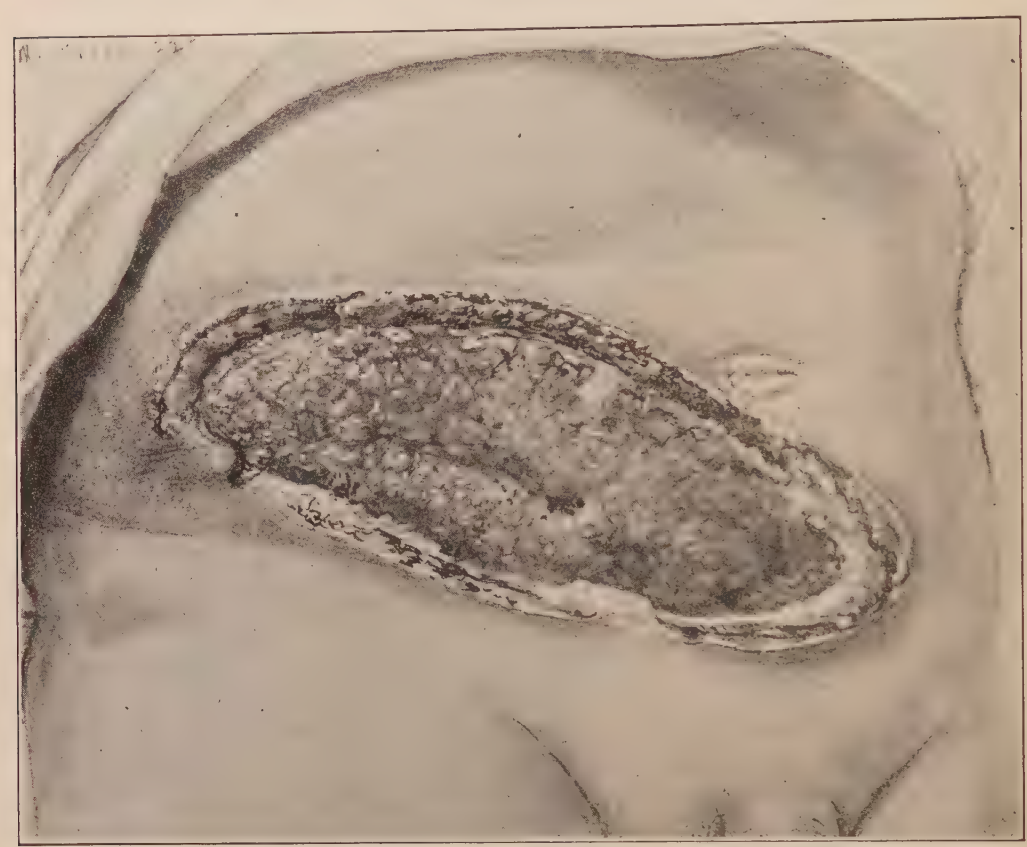

Fig. 35.—Progressively Enlarging Ulcer of the Abdominal Wall Following Drainage of an Appendical Abscess. (Thomas S. Cullen.)

Sympathetic Neuromas of Appendicitis.—The sympathetic neuromas of appendicitis are discussed by Masson. When the appendix is being obliterated the nerve terminals are liable to proliferate and form typical neuromata. Contraction causes pressure and sets up reflex pain, as does a neuroma in an amputation stump. Three of Masson's cases stood out; in one was found a cancer of the ileocecal valve; in the second, abdominal section was performed for pain and tenderness of the stomach, in which no lesion was found, but a neuroma of the appendix; the third gave merely a history of chronic appendicitis. Neuroma formation was found in all but one of ten cases of obliterative appendicitis.

Allergy.—The incidence of allergy as a complication of or a substitute for appendicitis formed the subject for investigation by Lintz in over three hundred consecutive office patients. Under the syndrome of allergy, which he regards as a specific disease, inherited and familial, are included asthma, hay-fever, dermal eruptions, gastro-intestinal upsets, etc. Such conditions should be ruled out in the diagnosis or confirmed in considering the complications. No class of cases is operated on so much; no class is benefited so little by these operations. A tender McBurney point means nothing, but the absence of rigidity is striking in these patients, contra-indicating operation. Even the discovery of a "pathological appendix" in an anaphylactic patient does not justify the operation, according to Lintz, since an anatomically normal appendix is a rarity. Allergic patients often develop skin rashes following operations.

Inflammatory Tumor Due to Foreign Body in Appendix.—A peculiar complication was that reported by Villette—an inflammatory tumor due to a foreign body in the appendix. A man, fifty-seven years old had a dense and indolent mass in the right iliac fossa. It was the size of a small egg, situated at McBurney's point, elongated in the direction of the fibers of the internal oblique muscle and adherent to the posterior aspect of the anterior abdominal wall. The patient had been nonfebrile for several weeks. Diagnosis varied between appendicitis, ileocecal tuberculosis, cancer, and actinomycosis. Radiological investigation proved the relation of the tumor with the cecal border and the intestinal loop (Fig. 36), and allowed the diagnosis of appendicitis with foreign body, and with inflammatory reaction about it. The position of the intestinal loop, forced toward the median line, indicated that the tumor could be approached by an external route. At operation two days later, by careful dissection was accomplished the removal of the appendix, the external half of which was surrounded by an inflammatory tumor adherent to the intestine, and to the peritoneum of the wall. When the appendix was dissected a flattened No. 8 lead shot was found in the tip (Fig. 37). The patient thought that this had been eaten with a piece of venison five or six months previously. Recovery took place.

Persistence of Vitelline Vessels.—Usadel reports the following case: A woman, twenty-one years old, was operated on for acute appendicitis. A vitelline vessel, the size of a lead pencil, was included in the large conglomerate tumor. It had been fixed to the outer abdominal wall in the umbilical region and with the other end at the mesentery to the small intestine, about 1 centimeter above the ileocecal valve, the usual site of Meckel's diverticulum. The strand was removed flush with its point of insertion. Bleeding occurred from one of its vessels in the stump at the end connecting with the mesentery. A purulent appendix was removed. The extirpated strand was 20 centimeters long and contained several vessels partly filled with blood. Vitelline vessels without the presence of Meckel's diverticulum are rare. Wilms collected nine cases from the literature.

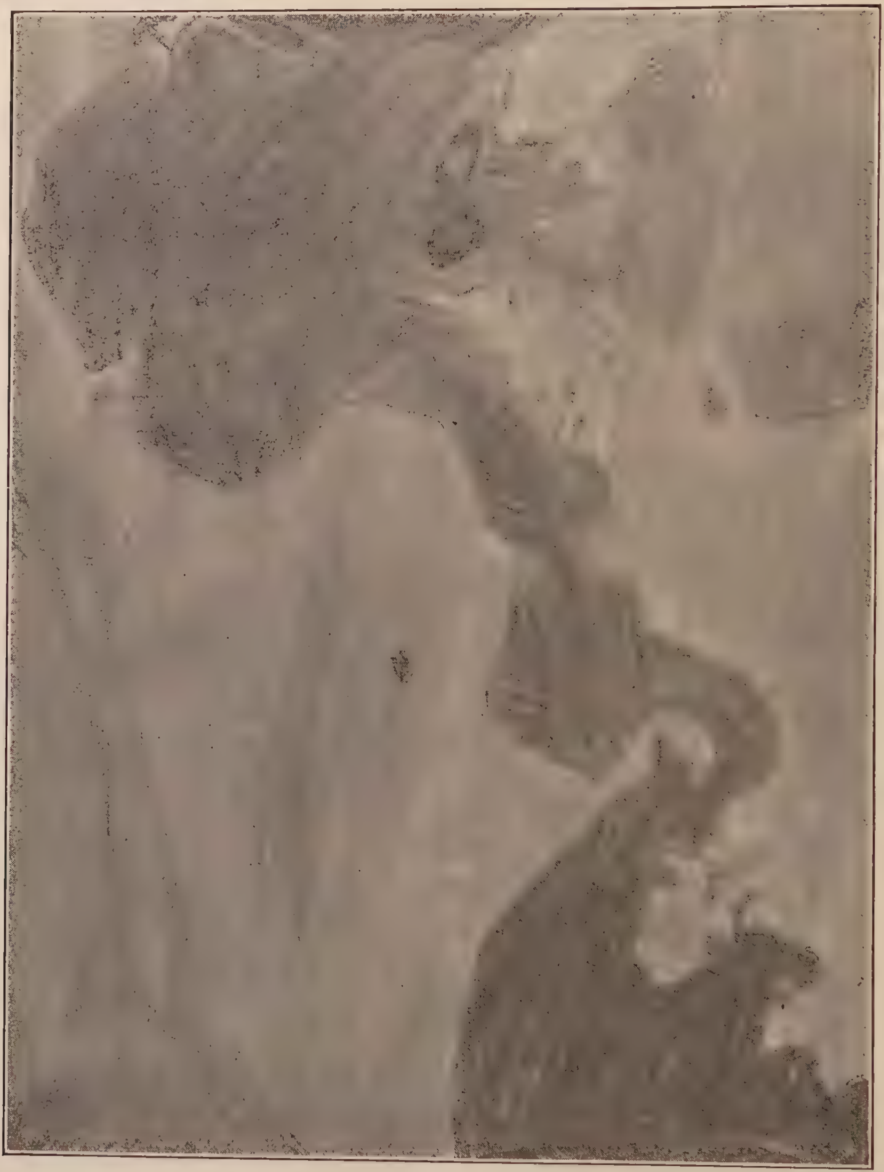

Fig. 36.—Radiograph of the Right Iliac Fossa, Five Hours after Opaque Meal. Presence of a Flattened Shot in the Tip of Appendix. (After Villette.)

Congenital Anomaly of the Ascending Colon.—Appendicitis with congenital anomaly of the ascending colon is the basis of a report by Rapp. A woman, aged thirty-five, had been under treatment for six weeks for supposed gall-stone disease, when acute symptoms developed calling for immediate operation. The liver and gall-bladder were found normal. A very long appendix was lying directly under the liver, as the cecum passed directly into the transverse colon. The ascending colon was absent. The orificial entrance of the ileum was at the posterior wall of the cecum to the left, which continued in a funnel shape into the appendix. The very fatty mesentery was adherent to the mesocolon by a fibrous membrane and from this fine connective tissue strands crossed over to the transverse colon. Rapp also says that several years ago Karewski reported a similar case of arrested development of the ascending colon at the third month of embryonal life in a boy of six years with acute appendicitis.

Injury in Gun-Shot Wounds of the Abdomen.—So rarely is the appendix injured in gun-shot wounds of the abdomen that I cannot resist the temptation to report the following most remarkable case from my own records:

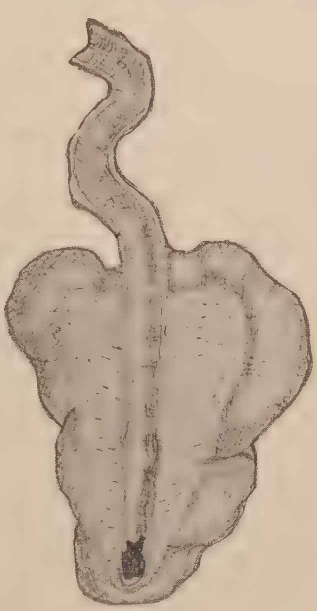

FIG. 37.—SECTION OF APPENDIX AND INFLAMMATORY TUMOR. FLATTENED SHOT IN THE TIP. (Reduced $\frac{2}{3}$.) (After Villette.)

J. M., a strong, healthy, colored man, while on a moving train, received a pistol ball in the abdomen at close range. Seven hours after the shooting, external examination disclosed a wound in the right iliac region on a level with the umbilicus and 5 inches distant to the right. Immediate operation showed that there were but two perforations, both in the cecum, one anterior and one posterior, wounds of entrance and exit. But the bullet track passed through the base of the appendix, which was torn completely off, except where it hung by a slender strip of bowel wall. Its tip was also attached by old adhesions to the ileum and postcecal tissues. (This is interesting in view of the history afterwards obtained that the man had been laid off duty for two weeks over a year previous on account of a severe attack of "colic.") The threadlike process holding the appendix was snipped off and all three perforations were closed by sutures; drainage was secured. Equally as interesting as the operative findings was the subsequent course of the case. The convalescence was comfortable and at no time were there dangerous symptoms. Two days after operation the urine was bloody. Two weeks afterwards the temperature was high; tenderness and bulging came in the right lumbar region and a mural abscess around the abdominal incision was evacuated. Nothing eventful then took place until nearly two months afterward when an astonishing thing happened. At 6 A.M., while the man was on the commode, the first time that he had assumed the upright position, he passed *the bullet from his rectum!* No happier ending to a desperate case could have occurred. One of two theories might explain the discharge of the ball from the bowel: first, that the bullet, its force being spent, entered the cecum at the time; second, that the missile lodged in the tissue of the retrocecal region and made its way into the bowel later. The bloody urine early and the lumbar swelling later support the second theory.

Appendix as a Focus of Infection.—For the past several years focal infections have held sway in medical circles. When it was demonstrated that microörganisms and toxins of disease could be transferred from one part of the body to another through the blood or lymph stream and set up infection in the secondary situation, it became evident that certain lesions known to be related were in reality due to the same proximate cause directly conveyed. The teeth and the tonsils at once leaped into prominence as the chief foci of infections, the bases of supply, the original harbors of organisms elaborating poison to affect the joints, the heart, the mucous membranes and glandular structures. The mouth and the throat, so easily accessible, yielded concrete testimony upon which could be predicated the origin of such infections. Gradually other regions and different organs have been proved to act as sources of focal infection.

It is difficult, however, to get away from the teeth and the tonsils. It is true that a general agreement includes diseases of the gums and jaws with the former and infections of the nasal accessory sinuses with the latter; but the average medical man thinks almost exclusively in terms of these two structures—teeth and tonsils—when focal infections are discussed. Some years ago I proposed an alliterative slogan of homely sound and name to cover all possible foci. I suggested the "three T's"—Teeth, Tonsils, Tummy. The latter means the abdominal cavity, and includes the appendix, the intestinal canal, the genito-urinary organs in both sexes, the prostate in men and the fallopian tube in women. It is usually understood that all these organs are involved secondarily from other foci, but very definitely and frequently they are also the primary and unsuspected seats of disease existing elsewhere in the body.

The vermiform appendix is probably more often a focus of infection than is generally realized. Its relation to the tonsil has been discussed. Moreover the fact that it has been called "the abdominal tonsil" shows that the appendix is abundantly supplied with lymphoid tissue, and that it both receives and dispenses toxins. Ever since Dieulafoy in 1898 announced his theory of toxic appendicitis (appendicemia) sufficient evidence has accumulated to convince the most skeptical, and yet this aspect of the disease fails to command universal attention. Dieulafoy's dictum may be summed up as follows: "Appendicitis results from the transformation of a part of the appendicular canal into a closed cavity, which becomes a focus of infection and intoxication, due to the increased virulence of the imprisoned microbes." Within this focus toxins are manufactured. They are absorbed rapidly into the blood far ahead of infective microbes and give rise to systemic symptoms in distant organs—in the kidney, producing albuminuria; in the liver, icterus;

in the stomach, hematemesis. More rarely complications of the central nervous mechanism were noted—epileptiform attacks, coma, etc. Arthritis and various other affections were not mentioned, because at that time it was not admitted that living bacteria could circulate in the blood stream with impunity. "Focal infections," so to speak, were not directly proven. But these studies of Dieulafoy led to the recognition of the appendix as a cause of general lesions and pointed the way to the now accepted explanations of its relation to sundry symptoms in remote areas.

French surgical authors took up the question widely and spoke constantly of "hypertoxic appendicitis." This complex was described as a rapidly developing toxi-infection of the appendix, frequently accompanied with diarrhea; showing diffuse, not localized, pain and tenderness and a decidedly bad general state from the beginning. Abnormal activity of bacteria is notable—colon bacilli always, streptococci frequently and anaërobic bacilli in the graver cases.

D'Acierno, by the way, regards toxic appendicitis as rare, classing it rather as fulminating. He goes on to say that there are other cases characterized by transient tenderness and pain in the appendix region and by absence of other signs or symptoms of appendicitis which occur at times in the course of some infectious diseases (acute rheumatism, tonsillitis) or mineral poisoning (saturnism) or primary anemias (pernicious anemia) or anaphylactic disturbances (urticaria, eczema, serum disease) and undoubtedly are due to toxic substances in the blood stream which stimulate and irritate the nerves of the appendix without causing any clinical sequence in it. For this group, the term "appendicodynia" is suggested by D'Acierno.

Other clinicians observed results in cases of long-standing toxic affections relieved after removal of the appendix. Allbutt noted the permanent cure of a *neurasthenic woman* by appendicectomy. Afterwards the history of an old peritonitis in youth was recalled. Lambret chronicled a case of toxic ill health in which after removal of the appendix an *ophthalmic migraine* was cured and *epileptiform attacks* of digestive origin with a cecal aura were benefited. Martley presented a patient who had had twelve attacks of *Ménière's* disease before acute appendicitis seized him; four years after the operation he was free from recurrence.

Following these reports came an account by Rosenthal detailing seven cases in which removal of the appendix for the cure of *trifacial neuralgia* and other nerve pain about the head and face produced what he called "startling results." With one exception each patient came out of the anesthetic free from pain and remained so. A single case, the only infected appendix, gave gradual reduction of the pain. All cases had been treated exhaustively for months or years for intractable pain with no relief until the appendix was removed. Rosenthal does not claim from this small experience to have established a new morbid anatomy for trifacial tic and kindred affections, but he does claim in seven cases to have fixed the pathology in the vermiform appendix even though the physical and subjective evidence of appendicitis was so obscure as to be entirely overlooked. In all but one case there was present almost symptomless chronic appendicitis of the obliterating type; the other was a symptomless case also, but the appendix was distended with staphylococcus pus. It is very probable that a report of one hundred cases might reveal some further startling results in a condition where even a successful gasserian operation frequently results in recurrence and might explain the unsatisfactory results from resection or avulsion of the nerve as well as from injections used with view to chemical nerve destruction. One case of his series is more on the order of migraine, or so-called sick headache. It has not been uncommon in his experience to note cure of migraine after removal of a diseased appendix.

From the prompt cessation of pain in six of these cases, Rosenthal concluded that the disturbance was a toxemia with selective action, and that if the tonsils, teeth and hollow bone cavities give rise to toxemias and bacteriemias of such far-reaching effect, it is not surprising that the appendix, a hollow abdominal organ with its possibilities of aërobic and anaërobic bacterial development, should give rise to a toxemia which is the basis of a selective neuritis or nerve irritation.

Without disparaging these results and without objecting in any way to the plan pursued, one might suggest that all forms of trifacial neuralgia show a tendency toward remissions and that sufficient time must always relapse for clear judgment. Furthermore there were other factors in some of the cases, treatment of which was under way. Still the toxic appendix is here exemplified and might have been the "last straw." On the whole the report is significant.

My experience in attempts to relieve headaches and neuralgias of cephalic location by appendicectomy have not been encouraging; but two cases of severe and protracted sciatica, unaffected by the usual modes of treatment, were permanently cured by removal of the appendix, which was indicted on suspicion. In each case staphylococcic pus was encased within a "tight" appendix. It has now been nine years in one case and five years in the other since operation, without recurrence of the sciatic pain.

Discussing the sensory visceral reflexes Arillaga refers to a young woman with neuralgia of the eleventh dorsal nerve and an intensely tender point at the McBurney area. Light pinching of a fold in the abdominal wall produced pain in the appendix region. The reporter said it was due to "a torpid lesion in the right ovary." Also he presented a woman of forty-seven years with the same complaint who was made better from injection of the eleventh nerve with procain. Appendicectomy in both cases gave no relief from the neuralgia. Arillaga observes that when the appendix is responsible for this reflex, the pains are more paroxysmal; but with pelvic lesions the pains are persisting.

A remarkable report by Descomps brings out very clearly the focal character of appendical inflammation. He speaks of "appendicitis without peritonitis," as being in many ways the most serious form in that such cases, when acute, demand most imperative attention and, when milder, they represent the first step toward localized or general peritonitis. The former are looked upon as virulent toxemias; the latter are the torpid toxemias. Limitation of local symptoms is a marked feature, as the appendix is without essential function; but the systemic symptoms on the order of intoxication predominate, "a general toxemic syndrome, whose origin is appendicular, but whose major manifestations are indirect, distant, dispersed, difficult to understand, to coördinate, to interpret and to trace back to their true cause." The term "attack" is vague and unmeaning, frequently signifying the existence of some local complication; or it may be only a very acute appendicitis without peritonitis but with primary toxemia. Hypervirulent agents distill toxins in the focus and these, carried away in the circulatory stream, give rise to general symptoms resembling those of the severe poisonings, endogenous or exogenous.

As Descomps further says, in the great majority of cases, one will find antecedents of masked, attenuated, premonitory toxemia. For just as acute toxemia is the prelude of appendicular peritonitis, slight torpid toxemia is the prelude to this acute toxemia and its first indication. This torpid toxemia corresponds to what, in current language, one calls chronic appendicitis. The acute toxemia attack is preceded, or proved by, the accentuation of a chronic toxemic condition. Without doubt some appendices rupture suddenly, and reveal themselves only by the precipitate appearance of symptoms more or less serious which constitute the acute attack. But, laying aside the accepted idea of previous attacks, "the attack" is almost always preceded by a prodromal period, which corresponds to the intra-appendicular development of the lesions, at the beginning of the acute infection. This period of appreciable symptoms may be short, from twelve to twenty-four hours; often it lasts two or more days. There is a series of disturbances sometimes poorly defined, ordinarily gastro-intestinal manifestations: lack of appetite, constipation or diarrhea, vague pains (usually epigastric), sometimes nausea, distention of the stomach after eating, especially fatigue, depression and unfitness for work.

"Rheumatic Appendicitis" is the title of a paper by Bindi, who presented as an example of hematogenous infection the case of a man, thirty-two years old, previously subject to abdominal pains after heavy meals. An acute attack of this sort enabled Bindi to see the patient and make a diagnosis of appendicitis. Recovery took place and the patient was well until a year later, when he came down suddenly with acute polyarticular rheumatism. On the fifth day of his illness he was again seized with abdominal pain, vomiting, right iliac resistance and tenderness, and later a mass. Treatment consisted in endovenous administration of corrosive sublimate, two or three days apart, until four injections were given and the patient's convalescence was complete in nineteen days. Bindi regards the arousing of this appendicitis during the development of ordinary rheumatism as something more than accidental; and concludes that there is a form of appendicitis exhibiting the arthritic type, although literature is silent on the matter. He argues for the blood stream origin of appendical infection, believing that the agent of acute articular rheumatism may localize in an anomalous situation, such for example as the appendix, and thus give rise to a variety of rheumatic appendicitis.

A case in point was recently published by Ruiz. A man gave a history of rheumatism five years before, lasting one year. Without any known cause he began having continuous pains in the right flank and a small hard tumor, painful to the touch, appeared at this site. He had chills and fever and lost 20 pounds in weight during the twenty-five days since the onset of pain. Diagnosis: perirenal abscess. Exploratory puncture of the tumor through the external border of the lumbar muscles yielded 10 c.c. of yellow fluid and fetid pus. Operation revealed a necrosed appendix, which had perforated and formed a retrocecal abscess. Recovery was slow. As noted by Moore, and known and observed by many others, synovitis and arthritis occasionally occur as a part of the pathology, arthritis probably being the more common of the two conditions, and clearing up readily after removal of the offending organ. As an instance of focal relation at the opposite end of the line Baese reported a case of *appendicitis following a felon,* and while admitting that the causes of appendicitis are many, he discusses the various ways the microorganisms would take to reach the organ; stating that in his case the patient had carried his infected finger to his mouth, provoking thus an infection of the digestive tract and then the appendicitis. This is abstracted from the article by Bindi who remarks that such a manner of determining the cause of the secondary disease seems to him questionable and perhaps even fantastic, while the concept of a septicemic condition may more reasonably explain the appendicular attack.

Further observations by Moore justify him in saying that certainly many cases of appendicitis, especially of the chronic type, are associated with infections of the teeth, gums and alveolar process, or with cryptic *infected tonsils.* Moreover he believes that *neurasthenia* is frequent as a result of the absorption of toxins from the infected appendix and its accompanying intestinal intoxication, as well as from the various symptoms of its associated ailments. Cardiac symptoms, he thinks, may occur as a result of the toxins being distributed through the blood stream and the extra demands made upon the heart muscle by a poisoned organism. As a rule, in chronic appendicitis these heart conditions are functional, but they may become organic and permanent damage may result, if there is sufficient absorption and if the focus of infection remains long enough to overcome the resistance of the myocardium.

In a paper upon chronic appendicitis Battle refers to a report by Usland. This contained a description of five cases presenting urinary symptoms due to bacilli. After removal of the appendix in each case the symptoms disappeared. Germs similar to those in the appendices were found in the urine. Battle also introduces the following editorial from the *Lancet,* same issue:

"The doctrine of focal infection has now reached a state when it is liable to be parodied by undiscriminating enthusiasts and to fall into disrepute. But papers such as Dr. Usland's make it transparently clear that this doctrine contains more than a modicum of truth, and that it leads to therapeutic measures which would probably have been neglected without it."

Looking at the question with the eye of histological physiology Gruner believes that even without as much as the mildest clinical degree of appendicitis toxic substances may pass from unhealthy or contaminated fecal matter into the vascular streams of the appendicular wall; and that these passing by devious ways upwards into the general circulation, may be the cause not only of hyperchlorhydria and of gastric hemorrhages, but also of the "chronic ailing" which is so often found in practice, and for which the most careful clinical examination finds no definite basis.

From long observation of focal infection and its relation to intra-abdominal disease, Sheldon and Heller have found this relation to be very definite. These writers, therefore, remove the foci at the same time as an appendicectomy is done or soon after. The foci most frequently found are the tonsils, occasionally the teeth and other organs.

Careful history taking has convinced Williams of the relative frequency of appendicitis in patients with *nasal sinus infection.* Within two years an analysis of ninety cases of nasal sinusitis demonstrated that fourteen had undergone appendicectomy—over 15.5 per cent. In several cases Williams judged that the length of time between the appendix operation and the recognition of the sinus infection was too long to justify the assumption of a causal interdependence; he further asserts that sinusitis will show prolonged latent periods and then exhibit exacerbations from intercurrent disease which make it appear that the nasal infection has arisen *de novo.* Furthermore it is unlikely that acute suppurative sinusitis will cause appendicitis, inasmuch as it is then an acute focal infection, while the gastro-intestinal tract will be more prone to succumb to a chronic or recurring mass infection from a constant swallowing of organisms. The incidence of sinus infection in patients with appendicitis according to Williams could be more acutely determined by exploring the maxillary antra and sphenoidal sinuses of every patient submitted to appendicectomy and a considerable percentage of such cases would reveal sinus infection previously unsuspected. It is not suggested that either gastric or duodenal ulcer, or appendicitis are always or even usually, due to a nasal trouble, but the relatively frequency of their concomitance seems worthy of note and of further investigation.

In his paper published in 1922 Hurst was of the opinion that the appendix is capable of acting as a focus of infection which may give rise to *acute ulcers* of the *stomach and duodenum.* These do not appear to give symptoms in the majority of cases, but erosion of a blood-vessel may occur with hematemesis and in rare cases such an ulcer may perforate. Most often, says Hurst, the hematemesis is either preceded nor accompanied by gastric symptoms. If they do occur they are not due to acute ulcer, but to reflex "appendicular dyspepsia"; or they may be due to accidental association with nervous dyspepsia or with the dyspepsia so common in chlorotic girls, independently of their possible association with chronic appendicitis or acute gastric ulcer, or both. Under certain conditions the acute ulcers, which result from infection of the appendix or elsewhere, may become chronic, but much more often they heal rapidly.

Appendix and Situs inversus.—The appendix may be found on the left side of the abdomen from two entirely different sets of causes. First, it may be so long as to reach all the way from its base normally located on the right until its tip, or even more of it, is situated on the left, or an appendix of average length can be pushed or pulled over by adhesions so that it occupies a position more on the left than on the right; second, the appendix may lie wholly on the left side on account of *situs viscerum inversus,* or transposition of viscera. In either case we would here be concerned with abnormality only if the misplaced appendix were the seat of disease.

An unusually long appendix, pointing inward, across, or downward and to the left, when inflamed, may give left-sided symptoms and yet its point of maximum tenderness and rigidity still be noted at McBurney's point, representing the base of the appendix or the nerve areas supplying it. Rupture at the tip, however, would present a different picture. Localized peritonitis would set up in the left iliac region, instead of the right, and later a left-sided abscess might form. In such conditions the most astute observer is apt to be led astray. Unless one is constantly on guard, mistakes will be made; and a few errors will occur in spite of the closest scrutiny.

The same conditions will hold good in the event of an appendix stretched over and adherent on the left, except that the tender point and all the signs are on the left from the beginning. This is accounted for by the fact that the cecum is displaced by the same factors which cause the change in position of the appendix. This type of left-sided appendix represents a pathological state, already present, and an acute or chronic process has set up, to go on to its fulfillment.

Left-sided abscess may result in either of these two conditions—an abnormally long appendix perforated at the tip or an appendix adherent far over on the left and also perforated or gangrenous. But there are other conditions under which left-sided abscesses may occur. They may result from direct communication with a normally placed diseased appendix; they may arise from encapsulated collections of primarily or secondarily infected exudate. The inclusion of septic material is of slow development and usually many days elapse before the condition is noted. Nather and Ochsner regard left-sided abscess as relatively rare. It represents a typical complication both in the conservative and the operative treatment of appendicitis. The clinical symptoms are like those of any other intra-abdominal abscess. It is found mostly in children. In nine cases seen by these writers four were in children, all under twelve years.

This ratio of occurrences is even less for children than is the usual percentage in the work of surgeons generally. At least two-thirds of left-sided abscess on my records were observed in patients under twelve. But adults are by no means exempt.

It would be interesting and instructive to record here the anatomical story of the origin of situs inversus. But such a narrative would lead us too far afield. We must confine ourselves to the discussion of appendicitis occurring in patients who are the subjects of visceral transposition. It is impossible, of course, to determine the exact frequency of situs inversus cases. Many of them exist without recognition and most of those recorded have been discovered accidentally or as the consequence of a mistaken diagnosis.

According to Sherrill, "Transposition of the abdominal organs occurs in total transposition of the viscera. Partial situs transversus is much less frequent than total transposition which is itself quite rare." He shows, also, from a comparison of early and late reports that "cases of visceral transposition are recognized with relatively much greater frequency during life than was formerly the case." More careful clinical examinations and the extended use of the x-ray have contributed to their relative frequency. Obviously there is no way of ascertaining the actual percentage in all of the human race.

Up to 1906 Sorge collected only 214 cases. He found that the first x-ray picture of a case of visceral transposition was published by Vehemeyer in 1897. According to the statements of experienced roentgenologists, displacement of the heart to the right and visceral transpositions are not exceedingly rare, as was formerly supposed (Jacobson).

According to Jacobson it appears that Mühsam (1911) was the first to report an operation deliberately planned for left-sided appendicitis in total inversion of the viscera; Hollenbach in 1912 reported the second and Jacobson himself the third. In Mühsam's case the transposition was known for fifteen years before the operation. Hollenbach's case was diagnosed previous to operation by the x-ray. In Jacobson's case the transposition was unknown before the operation.

When acute appendicitis occurs in a patient with transposed abdominal viscera, unless this anomaly has been previously recognized, nine times out of ten the right abdomen is first opened at operation and then a second incision made on the left side. This has been the almost universal order. Curiously enough the right iliac region still presents the strongest claim upon our attention and in certain cases, indeed even when the appendix is located elsewhere, the pain often will be felt at this area. Hörnicke says that a slight inflammation of the appendix in situs inversus or other abnormal positions of the appendix gives pain at McBurney's point, but that when the parietal peritoneum is affected, the pain is localized correctly.

In two cases of left-sided appendix described by Ibardia the pains were felt at the usual points. Evidently the innervation, as he says, had not been disturbed, in spite of the transposition and the torsion of the colon in one case.

An increasingly larger number are being discovered in the left iliac region before operation and yet in medical literature, and even in the public press now and then, cases are still spoken of as having the usual right abdominal incision made only to be supplemented by a similar incision on the left when the abnormality is seen. As a rule this double incision is productive of no great harm and in the chronic or unruptured acute cases it makes little difference. It would appear better, however, to avoid the necessity of two incisions, if possible, particularly in the suppurative or peritonitis cases. Attentive examination while remembering the possibility of situs inversus as a complication will reduce these lapses to the smallest percentage. The prospective patient who jokes about which side his appendix is on may prove to have one on his left from congenital causes.

The latest available summary of reported cases is that of B. C. Willis. In it he gives a list of fifteen cases of appendicitis with complete transposition of the viscera, and adds one of his own. Of these sixteen cases eleven were known to be of the acute variety, most of them gangrenous or perforated, while three were chronic in type, one subacute and one not classified. Jacobson's review of eleven cases, beside his own, seems to include seven cases not mentioned by Willis. Analysis of these cases shows that only in three, which include Jacobson's, was the diagnosis made previous to operation and the appendix removed through an incision made deliberately in the left side of the abdomen. In three cases the condition was unsuspected and diagnosis made only after the abdominal cavity had been opened; in four cases a clinical diagnosis was made and the patient treated medically, no operation being performed. In the remaining two cases the condition was found only at autopsy. On the other hand Willis published at least six cases not reviewed by Jacobson, although they appeared in print before the latter's paper. So that the actual number of cases would mount up higher than either of these observers estimated.

The case of Pool illustrates a point, in that after making an incision in the right lower abdominal quadrant, finding exudate on the intestines and identifying the sigmoid flexure, he prolonged the incision upward by the rectus sheath, through which inspection of the hepatic region failed to disclose an undescended cecum; whereupon he suspected transposition of the viscera, made a left iliac incision, verified the suspicion and removed a perforated appendix. There was free pus under tension in the right iliac fossa up toward the liver and a small amount in the pelvis. Convalescence was normal except for suppuration in both wounds.

Exploration of the hepatic flexure is an important step when the appendix is missing from the right iliac fossa, for failure of the cecum to descend, absence of the ascending colon, or other right-sided abnormality might account for it. A longer right rectus incision then would be indicated rather than a secondary left-sided incision.

Jacobson observes that up to the time of his paper in all cases reported there appears to have been a history of previous attacks of abdominal pain. This leads him to conclude that the condition was unsuspected, otherwise an early operation would have been done.

In the two instances reported by Landgraf a correct preoperative diagnosis in each case was made. One was an acute case with definite signs of appendicitis in the left abdomen, in which autopsy showed a gangrenous appendix in the left hypochondrium and a typical situs inversus of the other organs. In the other case transposition of the organs was discovered accidentally when having x-ray examination done for "stomach trouble." The patient was cautioned to inform her attending physician of this anomaly in case she should have pain in the left abdomen, and in fact a year and a half later, she did have an attack of left-sided appendicitis and was operated on.

In a personal communication H. R. Shands, of Jackson, Mississippi, writes: "Ten years ago I operated upon a man for acute appendicitis. I found that he had completely transposed viscera—heart on right side, liver and gall-bladder on left side, sigmoid on right side, cecum and appendix on left side. A week ago I had occasion to operate upon this man's son for acute appendicitis and found the son's appendix in the left iliac fossa. There is heredity in transposed viscera. This man is the father of six children. I had all the children brought to the hospital and x-ray pictures taken and was disappointed in finding that all the rest of the children had their organs properly placed.

"The son did not have a complete transposition of the viscera. On opening his abdomen through a right rectus incision I could find no large intestine at all at first. After enlarging the incision I found that his liver was properly placed. He was a thin patient and with marked retraction I lifted up the abdominal wall and could see a little omentum at the splenic flexure. Following this I was able to pull up a movable cecum from the left iliac fossa. His bowel goes up normally to the splenic flexure and then drops directly back on itself into the left iliac fossa. There is no transverse colon across the abdomen at all" (Fig. 38).

Following is the account of his father's case: "C. M. M., white male, age 40, seized in summer of 1916 with typical symptoms of acute appendicitis with the exception of localized tenderness in right iliac fossa. The tenderness was general over the lower abdomen. The patient was otherwise in good health. Immediate operation was done on the diagnosis of acute appendicitis. On opening the abdomen through a right rectus incision, the cecum could not be located. After a little search what appeared to be the sigmoid was found in the right iliac fossa. Transposition of the viscera was suspected and the hand introduced to locate the liver. The liver and gall bladder were found missing in the right hypochondriac region. The hand was passed across the abdomen and the liver and gall bladder found in the left hypochondriac region.

"A small gridiron incision was then made in the left iliac fossa and an inflamed appendix removed. The patient made a smooth and uneventful convalescence and is still (1925) in perfect health. X-ray pictures made later demonstrated a complete transposition of both thoracic and abdominal viscera" (Fig. 39).

Finally I may be permitted to add the only case from my records in which appendicitis occurred in a patient who had transposed viscera: George W. S.,

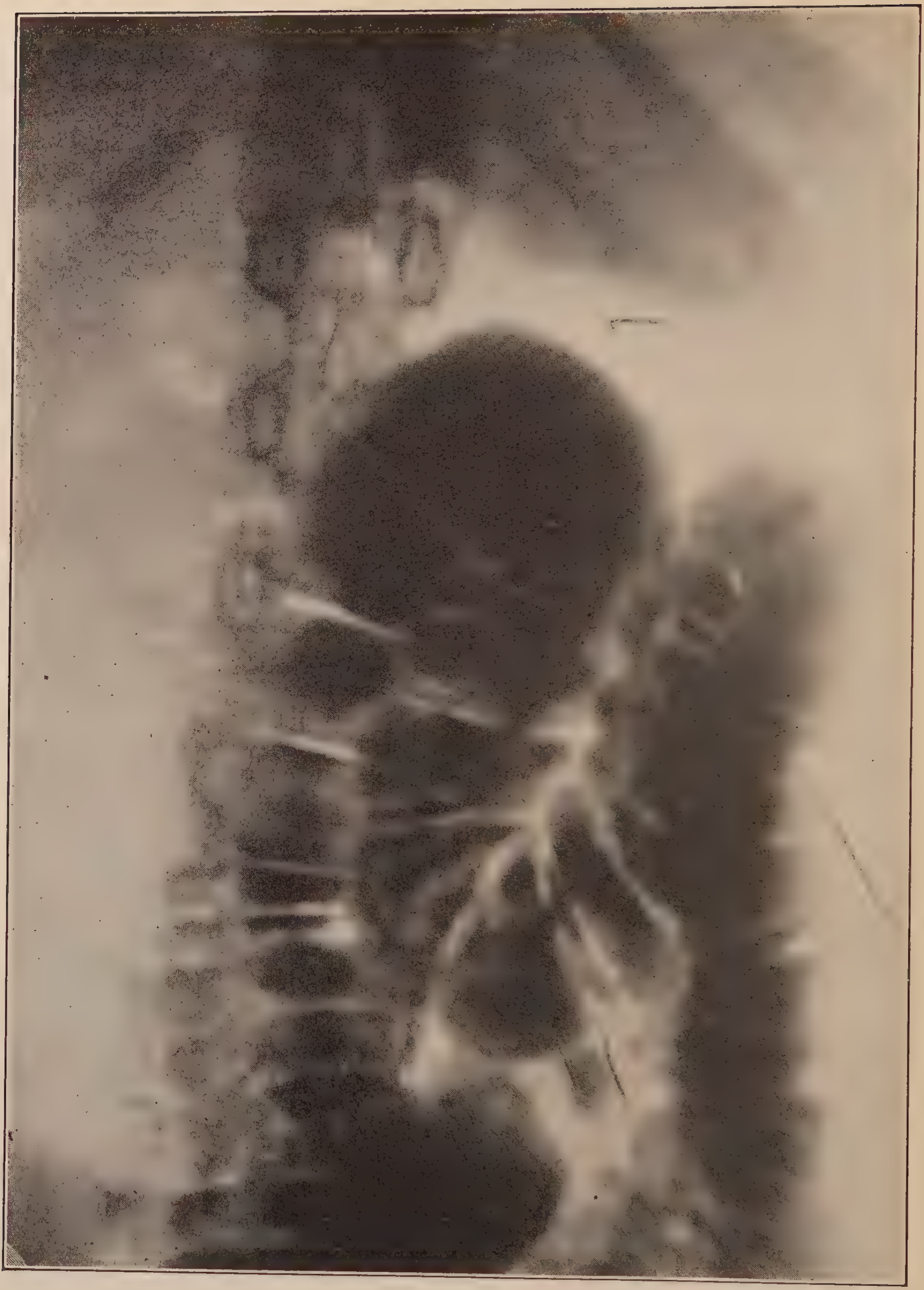

Fig. 38.—Cecum in Left Iliac Fossa; No Transverse Colon. (H. R. Shands.)

aged 26, had been suffering for several months with some obscure abdominal trouble. His chief complaint was gas pressure and a tender area in the right hypochondriac region. There was nothing definite or tangible either in the history or the physical examination beyond the fact that pressure in the *left* iliac region produced pain at the epigastrium. Examination of the blood, urine and feces proved negative. Roentgenologic study furnished the clew and made the diagnosis, for the patient had a complete transposition of viscera with a left-sided subacute appendicitis. Following is an abstract of Noble's report:

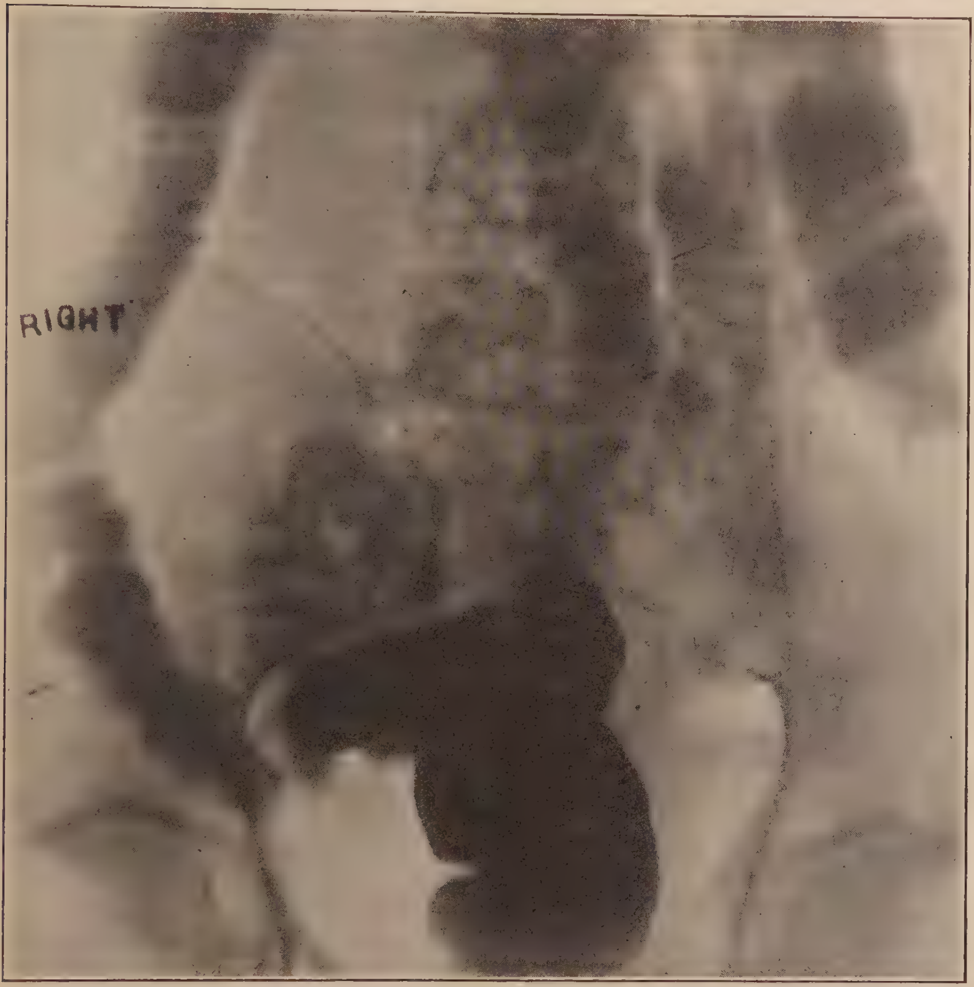

Fig. 39.—Complete Transposition of Viscera. Cecum on Left; Appendix Previously Removed. (H. R. Shands.)

"X-ray examination of the gastro-intestinal tract shows the stomach normal in shape and size, except that it is reversed in the abdomen, being found in the right hypochondriac and epigastric regions. The liver shadow was noticed on the left side. Contents of the stomach after taking the opaque meal passed out through the duodenum from the left side and on into the small intestine. No defect could be seen in the outline of the stomach. At the twenty-four-hour examination, the opaque mass had reached midway the transverse colon, which was also reversed in direction. The cecum and ascending colon were normal in size but were situated in the left side instead of the right. At the forty-eight-hour examination the mass had reached the rectum and seemed to be evenly distributed throughout the large intestine. Extreme colonic stasis. The patient was extremely tender over the region of the appendix which did not fill up during the examination. Deep palpation on the left side over the cecum caused sharp pains to radiate upward to the splenic flexure and under the right lower ribs (in the region of the tender area of which the patient continually complains). I believe the condition one of adhesions in the region of the splenic flexure, associated with chronic appendicitis. I would advise taking out the appendix and breaking the adhesions and exploring the abdomen, especially in the region of upper right quadrant."

Operation was performed five days later through a left rectus incision. The appendix, situated in the left iliac fossa, was red, edematous, curled up like a snail and stuck fast to the cecum. It was tied and invaginated. There were some adhesions around the ileocecal region, but none elsewhere. A moderate "Lane kink" was present. Exploration noted a normal gall-bladder on the left; the right hypochondrium was negative. Pain in that region might be explained by gaseous distention and ptosis. The patient made a prompt, comfortable recovery and has remained well ever since.

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CHAPTER IX

APPENDICITIS IN CHILDREN

Appendicitis in children merits a special chapter. The difficulties in its diagnosis, its relatively higher mortality, its frequent complications, its characteristic pathology give the disease a peculiar interest when occurring in early life. Practically every textbook on appendicitis devotes particular attention to the disease in children. In addition to this the volume of reports in the medical literature has grown to great proportions. From these sources and from the combined experience of my associates and myself it is purposed to set forth the present prevailing views upon this affection as it appears during the first twelve years of life.

As an introduction I am pleased to present the following thesis by my colleague, A. S. Root, whose practice is limited to the diseases of children. Root writes:

"Appendicitis is less frequent under ten years of age and the younger the child the more infrequent its occurrence. Griffith in 1901 reported only fourteen cases from the literature and one of his own, occurring in the first two years of life. Abt, in 1917, gathered eighty cases two years or younger. Of McCosh's one thousand operative cases of all ages, seventeen occurred in the first five years of life and fifty-one in ages from five to ten years. McGuire collected one hundred and four cases in children, three being under three years of age, forty-seven from three to eight years and fifty-four from nine to fourteen years. The youngest case I have seen was an infant three months of age who had a ruptured appendix completely walled off.

"H. C. Deaver's statistics of five hundred cases seem to indicate that the disease is more common in males, as three hundred and fifteen were boys and one hundred and eighty-five girls.

"*Symptoms.*—Undoubtedly appendicitis occurs with greater frequency in infancy than is generally supposed, and is not and cannot be recognized. *Simple catarrhal* appendicitis is not uncommon in children five to ten years of age. Nausea, pain in the pit of the abdomen, fever 100°–102° F., slight tenderness and resistance over the region of the appendix and moderate leukocytosis make up the diagnosis. *Suppurative* appendicitis may give the same symptoms as occur in adults. On the other hand the diagnosis may be extremely difficult. Persistent nausea and vomiting is the most important symptom. This alone, even in the absence of fever, leukocytosis, abdominal pain or muscular spasm should place one on guard, until known causes of the vomiting have been ruled out. In such cases the history of attacks of recurrent vomiting adds significance. By persistent vomiting is meant the vomiting of all foods and fluids taken, including water and continuing over a period of thirty-six hours or more. Such vomiting is due to acidosis and may be accompanied by hyperpnea and rapid dehydration. I have seen two cases which presented only these symptoms but developed the 'abdominal facies' on the third day. Both were operated on and both found to have ruptured appendices with the pus in the peritoneal cavity. One case died; the other, after a stormy convalescence, came through.

"*Chronic appendicitis* is not at all uncommon in children. The pathology is probably persistence of kinking or narrowing of the appendix lumen. This form is manifested very frequently by attacks of recurrent vomiting with or without abdominal pain. There is more frequently no fever. It is by no means true that all cases of recurrent vomiting are due to an abnormal appendix. In case of any child who has such attacks and where the underlying cause has been undetermined, a roentgenological investigation of the gastro-intestinal tract should be made. This will frequently, though not always, verify the diagnosis. Children suffering from this form of appendicitis not only have attacks of recurrent vomiting, but they are undernourished, have poor appetites, and suffer from vague digestive disturbances. The result of relieving them by removal of the appendix is often spectacular. In such suspected cases, conservatism in operating should naturally be practiced, but many cases with the help of the x-ray are so clear cut that there should be but little doubt as to procedure.

"*Prognosis.*—The prognosis in children is graver than in adults—the younger the child the more serious the result of the infection. This is because children have a lower resistance to infection and because it is so often difficult to diagnose the cases early. The tendency towards perforation is in inverse ratio to the age as is the tendency towards the occurrence of general peritonitis. The chief complications of appendicitis in children are: (1) general peritonitis and (2) acidosis. The latter may lead rapidly to an anhydremic state, unless fluid is artificially administered. *Differential diagnosis* must be made between acute appendicitis and (1) acute indigestion with fever; (2) intussusception; (3) typhoid fever; (4) pleurisy, with or without pneumonia, where the pleural pain is referred through the intercostal and abdominal nerves to the region of the appendix; (5) hysteria, in older children."

Age Distribution.—Reference has been made to the age distribution of appendicitis in the chapter on Etiology. In general it is admitted, as expressed by Howland, that it is distinctly uncommon in children under five years of age "and in those under two years it is really a rare disease." Schlossmann found that the literature, up to 1922, gave about thirty cases of appendicitis in children under two years. The appendicitis statistics of the Bremen Hospital for Children, he further states, show sixty cases operated on, of which thirty-five were under ten years. The youngest was one and a half years. Schlossmann is also authority for the following: Kirmisson collected twenty cases in children under two years, of which nine occurred in the first year and seventeen in the second; Deiss reports ninety-eight cases in children, of which seven occurred up to two years and 25 per cent were under five years; Goldzicher found 3.2 per cent of all cases were in the first decade. In Gardner's fifty-nine cases operated on, nine were under five and fifty between five and ten years. Dowd operated on seventy children, of which none was under two years. Maylard operated on one hundred patients, the youngest being between three and four years. From the statistics it is seen that the first year of life is quite free from the disease. In the second and third year it is a rarity. From the sixth year on the curve rapidly increases so that from the tenth to the fifteenth year it has reached 34 per cent.

Fifty-seven cases of the acute type were treated by T. H. Kelley in children under ten years of age. Five were under two years, one of them being six months old; twenty-one were under five years. Bolling's figures correspond closely with these. Out of one hundred cases of chronic appendicitis up to thirteen years of age, Mixter had nine under five years and the youngest patient was two and a half years. In Beekman's series of forty-three cases of children under five years, ten were in the third year, nine in the fourth and twenty-three in the fifth; the youngest patient was twenty months. Christopher recorded eighteen cases under five years from a total of 533 collected from one hospital. Seeger's list of sixty-one operations for appendicitis in children under thirteen years old showed none under two years and only four under five years.

In contrast to all these figures is a report by Peterson, who had a group of sixty-two cases in which forty-one occurred up to five years of age, five of these being under one year and five under two years. Twenty-one were seen between five and six years. Over 75 per cent of them were acute.

A review by Edberg includes 754 cases operated on for appendicitis in children from 1914 to 1923. There were thirty-eight deaths, 5 per cent. No fatalities occurred in the 164 cases of destructive appendicitis; four deaths happened in the 167 cases with localized peritonitis; thirty-three died in the 125 cases with diffuse peritonitis. In more than half of the chronic cases the operation revealed nothing to account for the clinical signs. Tuberculous lymphadenitis accounted for 1.2 per cent of the whole number; oxyuris for fifty cases exhibiting acute peritonitis. In the acute series (754 cases) only three of the children were less than a year old and only seventeen were less than two years. It is believed that the anatomic difference and the character of the food may prevent the frequent occurrence of appendicitis *in early infancy*.

On the whole these statistics of age incidence of appendicitis in childhood and infancy agree fairly well. Necessarily there are some discrepancies, owing to the personal equation, the type of practice or hospital service, the variation in the class of cases and a certain "run" of chance. Rather significantly it may be noticed that the number of appendicitis cases early in life seems to be on the increase. The explanation may be that they are positively more common or that they are looked for and diagnosed more intelligently and more promptly.

A case of acute appendicitis in a female infant of sixteen months is recorded by Sweet. She was brought to the doctor for a "cold on her lungs." The chest was found negative by x-ray examination and a diagnosis of appendicitis made. An abscess was opened and drained; the appendix was not removed; recovery ensued.

We are now prepared to take up the particular points pertaining to appendicitis in children, noting the differences between the disease in them and in adults and arriving at some conclusions in regard to diagnosis, prognosis, and management. Again we will call in the testimony of those authors just referred to and others upon the incidence of childhood appendicitis and bring their judgment to bear upon this important problem.

Varieties.—So succinctly has a certain form of the disease in childhood been described by Descomps that the following modified translation of an extract from his paper is here inserted: "In children one often observes the phenomenon so characteristic of sudden umbilical constriction, lasting two or three seconds, with a condition of malaise, and a peculiar pallor, which disappears immediately, but repeats itself at close intervals when the acute attack is imminent. This entire period of established malaise—if one allows the expression—a veritable condition of pain, terminates in the acute attack or on the contrary may become attenuated with the resolution. It is necessary to make the diagnosis at this time. It is more often possible and easier at this period than at the beginning of the attack, during the confusion and distraction of acute symptoms. If this diagnosis is not more regularly made in the prodromal period, it is because one has not thought of appendicitis; or that one has discarded the idea. Many patients and some doctors fear the word *appendicitis,* because this word leads to surgical intervention. This 'appendicophobia' is the source of many disasters. How many children have we seen, victims of a diagnosis of enteritis, entero-colitis, enteralgia, etc., the diagnosis holding until the moment when a diffuse peritonitis reveals itself by indications sufficiently clear to necessitate calling a surgeon, but likewise rendering an entire surgical operation insufficient."

This is a familiar picture to all those who have been called to consult over a young child having just enough disturbance to produce transient pain, nausea, and pallor around the mouth with a constant "run down" appearance and yet not definite enough symptoms to designate as an "attack" nor clear enough evidence to warrant a diagnosis of appendicitis. Avowal of the prodromal phenomena so graphically outlined above will keep one on guard and save many a life.

The variety of acute hypertoxic appendicitis is not infrequently met with in children, although it may be seen in adults. Its course is rapidly fatal, if early operation is not performed. The etiological factor is the presence and abnormal activity of virulent bacteria. Besides the colon bacillus there is often a strain of the streptococcus; in the intense hypertoxic type the anaërobic bacilli exist, notably the *B. aërogenes capsulatus.*

Discussing this particular phase of the disease, St. Jaques says:

"The clinical fact must ever be borne in mind that in children, so prone to pneumococcus peritonitis, which is usually primary without a former acute pneumococcus infection, this type of appendicular peritonitis is in the vast majority of cases accompanied at the very onset by diarrhea with persistent offensive stools."

Symptoms of this sort ushered in a case reported by Meyers, which also exhibited confusing meningeal signs. The patient was a girl of eight, who was admitted to the hospital for removal of enlarged tonsils and adenoids. Four days after admission she was seized with sudden, profuse, and continuous diarrhea lasting fifteen minutes; then for several days, constipation ensued. Shortly after the diarrhea had ceased, convulsions set in involving the whole body, which were controlled by bromids and chloroform. Next day she complained of pain in the abdomen. Examination showed tenderness in the right iliac fossa over McBurney's point. Babinski's sign was absent; pupils were normal; reflexes, normal. Diagnosis of acute appendicitis was made. Immediate operation revealed an elongated, distended, and acutely inflamed appendix, which was filled with hardened feces. A large number of shotty glands were seen in the mesentery. There was complete recovery with normal bowel function.

A study of 313 appendicitis cases in patients of fourteen years and younger made by Speed affords the following points: Chronic appendicitis though probably present in young children is not often recognized until a cathartic converts it into the acute category; the pathology is uncertain, its interpretation not to be relied on; the omentum in children is thin, short and of poor vascularization, inadequate as a protector against infection; 10 per cent of all the patients had fecal concretions in the appendix; fourteen patients had diarrhea before the attack, four during and seven after the attack and operation. Of the whole number, eighteen patients had diffuse peritonitis; eighty-two had intra-abdominal abscesses; eighty-seven, ruptured appendices; seventy-three gangrenous with and without abscess—260 cases out of 313 of the septic variety. Six patients gave a history of trauma, kicks in the abdomen. Nineteen patients died, and all of them were given purgatives before admission. Besides the usual symptoms a large number had chills and sweating; an abdominal mass may be felt early, but does not always mean a ruptured appendix with abscess. Rectal examination is recommended and opening of abscesses through the rectum when feasible; procrastination is not advised, but a gentle operation when the diagnosis is established, "approaching from the lateral aspect of the abdomen."

Differential Diagnosis of Acute Appendicitis.—The contribution of Helmholz concerns the matter of diagnosis in the acute variety. He attributes the high mortality of childhood appendicitis to its insidious onset and rapidity of rupture. Eliminating the abdominal prodromes of the acute infectious diseases and eliciting the history of previous attacks are very important.

Pneumonia.—Stressing its differentiation from pneumonia, Helmholz furnishes the following table:

	Pneumonia	*Appendicitis*
History	Previous cold or cough; Chest pain	Exceptionally influenza; usually none
Abdominal pain	Severe, constant, general	Paroxysmal, less intense, local
Vomiting	14 per cent	70 per cent
Diarrhea	Common	Uncommon
Facies	Appears ill, playing of alæ nasi; flushed	When uncomplicated not noticeable; pale
Respiratory signs	Shallow abdominal breathing, expiratory grunt; possible dullness and tubular breathing	Shallow costal breathing; no grunt or chest signs
Abdominal tenderness	Superficial, severe; diffuse higher in abdomen; no worse on deep pressure	Slight or severe; local; more marked on deep pressure
Rectal examination	Negative	Tenderness on right side
X-ray examination of chest	Positive	Negative
Leukocytes	20,000 to 50,000; uncomplicated	10,000 to 20,000
Temperature	103° to 105° F.	99° to 102° F.
Attitude	Irritable and restless	Lies quietly

Discussing pneumonia simulating appendicitis in young subjects, White regards a severe chill at the onset, a temperature over 102° F. and a leukocyte count at or beyond 20,000 as calling for extreme caution and rare judgment.

This is a wise suggestion. It is the case on the border line that worries, where the edges between the two are not clear-cut, where the signs are not marked one way or the other. The symptoms noted above might easily represent appendicitis and just as definitely suggest pneumonia. Here is a slogan to keep always in front of us, an aphorism of Trousseau: "Whenever an infant complains of pain in the abdomen, examine his chest."

According to Adams and Berger, in 145 cases of pneumonia in children from two to fifteen years of age, 17.5 per cent were incorrectly diagnosticated as acute appendicitis. As they assert, the symptoms of abdominal pain, vomiting and diarrhea are of no value, since they are frequent also in pneumonia. The patients with pneumonia are always more ill, present a characteristic general picture and show more systemic reaction; true, they exhibit abdominal spasm and tenderness, but of a different type. A hyperleukocytosis favors pneumonia except in diffuse peritonitis or abscess.

Auer presents a case of pneumonia simulating acute appendicitis: A girl eight years old whose trouble began with a sore throat and fever, but without a chill. Two days later she complained of pain in the abdomen and vomited. There was no cough. The chief symptom was abdominal pain. The lungs showed slight dullness over both bases posteriorly, the percussion notes on each side being about the same, but with no change in breath sounds and no râles; vocal fremitus was normal. The abdomen presented a rigidity of the whole right side with tenderness over the region of the appendix. The percussion note was tympanitic, temperature 102° F., pulse 95, and respiration 35. An ice-bag over the appendix relieved the pain and the other symptoms abated somewhat under symptomatic treatment for several days, when she developed a few moist râles in the base of the right lung posteriorly. On aspirating with the needle an ounce of thick green pus was obtained, which proved to be a pneumococcus infection. She now began to cough, twelve days after the onset, and developed a right empyema, which required resection of a rib and drainage. She made a slow recovery and was well a year later.

This case proved to Auer the difficulty of making a differential diagnosis between acute appendicitis and an acute respiratory infection. Here was an apparent history of previous attacks, fever, vomiting, pain, rigidity, and tenderness in right iliac fossa all of which pointed to the appendix as the offending organ. As he remarks, the lack of cough and practical absence of physical signs in the chest also tended to confuse; the slight dullness posteriorly being extremely difficult to demonstrate, because it was bilateral, so that the percussion note compared equally with the other side. He quotes Behrend to this effect: "The occurrence of appendicitis brings up the important difference between pneumonia and appendicitis. The closest observation and finest diagnostic acumen are required to differentiate between them. Even before the symptoms of pneumonia are absolute the one diagnostic point that helps more than any other is the respiration rate, with the playing of the alæ of the nose and the bright flush on the cheeks."

Both appendicitis and pneumonia may be present in the same patient. Reporting an instance of these combined infections Roberts found the laboratory of little assistance. He regards acute concurrent inflammations in different organs as indicating a blood-stream infection and the acute diseases as its local manifestations.

In a girl of ten years admitted on my hospital service, it was not difficult to recognize the simultaneous existence of a lobar pneumonia and an appendical abscess because the case was far advanced. Under local anesthesia the abscess was opened and drained through the rectum, where it was pointing; the lung lesion cleared up quickly, after which an abdominal incision was made and the appendix removed. The patient recovered sufficiently to be taken home against orders, only to be overfed and to return with acute intestinal obstruction from which it was impossible to save her.

Illustrative of the almost perfect resemblance between pneumonia and appendicitis, the following case abstracted from Adamas' book may be recited: A little girl, aged nine, was admitted suffering with vomiting and severe right-sided abdominal pain. She looked ill, her face was flushed, the alæ nasi were slightly active; the temperature was 106° F. (highest later 102° F.), pulse 120, respirations 36; no cough, no respiratory grunt; abdominal wall slightly tender and unusually rigid, especially at McBurney's point; rectal examination negative; on careful and repeated examinations the chest showed nothing abnormal. The abdomen was promptly opened and no lesion was found; the appendix was perfectly healthy. The child died two days after the operation. Autopsy revealed a small patch of central pneumonia in the lower lobe of the right lung.

Very likely at no time would the physical signs have been demonstrable, and yet less harm might have resulted from intelligent waiting. It is very easy to play a game after it is finished.

The acute infectious diseases of childhood constantly present confusing questions in relation to the diagnosis of appendicitis.

Measles.—Measles has been the source of much chagrin on the part of surgeons, for there is rarely one who has not been deceived by the appearance of the rash of this ubiquitous disease a day or two following an appendicectomy. There is no known exact method of saving this situation except by thinking of measles, and being sure of appendicitis. Koplik's spots ought to settle the question. The complication of measles with appendicitis is a very serious one. Both diseases may be present at the same time. Short had two cases of an authentic appendicitis coming on coincidentally with measles. In each case the appendix was acutely inflamed, swollen, buried in exudate. He operated on one case at a country farmhouse. The other children had measles. Perforation of the appendix had taken place; next day the measles rash came out and the boy died of pneumonia and peritonitis. In another case there was no reason to suspect measles; immediately after operation the boy had great difficulty in breathing and became dusky and the next day the right lung was solid with pneumonia. It was supposed that he had aspirated some vomit, but on the third day a measles rash appeared and the lung suddenly cleared up and the alarming symptoms passed away. No doubt the ether had converted a latent bronchitis which had given no evidence of its presence, into a severe pneumonia, albeit of brief duration.

Scarlet Fever.—In scarlet fever there would seem to be the same chance for error from hasty inference as in measles, but there are not nearly so many recorded or admitted cases. The very early appearance of the rash may account for the difference. Vysin operated on two children for appendicitis on account of acute abdominal pain in the beginning of scarlet fever. The wound suppurated in both cases, although the appendix was very slightly if at all diseased. This infection, in my opinion, might be explained by the streptococcus invasion of the skin or the blood. (For consideration of scarlet fever and appendicitis see Chapter on Complications, pages 223 and 224.)

Acute Mesenteric Lymphadenitis.—The great majority of cases of inflammation of the mesenteric lymph glands occur in young children, though adults also are affected. The usual origin has been supposed to be tuberculous. In the acute stage the resemblance to appendicitis is striking. A positive diagnosis often cannot be made. In lymphadenitis the patient does not look very ill, the constitutional disturbance is not marked; but, in my experience, the pain is quite severe, colicky, coming quickly in recurring spells and going quickly. Rigidity is notable; the tenderness is present but does not become localized. Struthers notes that during the acute stage the glands are not often or readily felt owing to the muscular resistance present. Under an anesthetic, however, he found that they may be easily palpated, and when several are adherent to each other the resulting lump tends to be higher and nearer the middle line than the swelling caused by an inflamed appendix with omentum or intestine adherent to it. After an acute attack the persistence of a lump and its situation may clear up the diagnosis. He admits exceeding difficulty in diagnosis, but observes that opening the abdomen in such cases does not appear to influence the glandular affection unfavorably; that the patients do well and no apparent extension of the disease has followed the operation. His report concerning the relative frequency of lymphadenitis embraced a total of twenty-two cases in 1919–1920 during which time he had 187 cases of appendicitis.

These conclusions are entirely in accord with my views. On the half dozen occasions in which I have operated for acute appendicitis in children or adolescents and found a general mesenteric lymphadenitis, I have been rewarded by the subsequent recovery of each patient and without a later return of symptoms. In two or three instances the appendix appeared more or less inflamed, but in none of them could we say that acute infectious appendicitis was present. One of the patients suffered two acute spells of pain just after the operation before final relief. In doubtful cases it is less dangerous to interfere surgically than to delay in possible cases of appendicitis in children who always are apt to have early perforations.

Freeman makes the following summary bearing on the cases he has observed:

"1. Mesenteric lymphadenitis is a common disease of children and young adults which has received too little attention from surgeons.

"2. It is characterized by enlargement of numerous lymph nodes, small and soft; the infective agents being in many instances, the tubercle bacillus, presumably of the bovine type.

"3. The most prominent symptoms are: moderate pain, tenderness, and rigidity, mostly in the right lower quadrant of the abdomen, often associated with slight fever, headaches, occasional colics, various gastro-intestinal symptoms, and loss of weight and energy.

"4. The disease is nearly always confused with appendicitis.

"5. Because surgeons are unfamiliar with the trouble, it is seldom recognized during operation.

"6. It has a strong tendency towards recovery, at least symptomatically following laparotomy."

A boy two years of age was seen by Speese and Klein. He was acutely ill, with a temperature of 102° F., general spasmodic abdominal pain, tenderness over the right lower quadrant, and a white cell-count of 22,250 and 80 per cent of polynuclears. A diagnosis of acute appendicitis was made. Operation revealed an adherent appendix and enlarged lymph-nodes in the terminal ileum—red and soft with smooth nontuberculous adenitis, secondary to the appendicitis.

This case represents a different entity from those reported in Freeman's article. It is just as important, however, in the matter of diagnosis.

It is of greatest practical importance, says Hollenbach, to know that tuberculosis of the glands at the ileocecal angle simulates both acute and chronic appendicitis, and that tuberculosis is more frequent in the cecum and ileum than in other portions of the intestinal tract. He had operated on six cases during the past four years, four with the picture of acute and two of chronic appendicitis. Operation consisted in extirpating as far as possible all lymph-nodes that could be reached. The appendix was also removed, although it showed no changes in any of the cases. In the acute cases the temperature dropped to normal soon after operation, and patients were freed from all symptoms. Only one case, a boy, returned after five weeks with the same symptoms. The rest of the cases were well after a year or more.

Three or four times Short opened the abdomen on a confident or tentative diagnosis of acute appendicitis and found nothing but tuberculous glands, few or many, either in the mesentery, or retroperitoneal in the angle between the termination of the ileum and the cecum. In one case the appendix was also slightly inflamed, probably not enough to give rise to a temperature, and the lymphatic glands in the area draining the appendix showed some swelling and redness superadded to an old-standing enlargement due to tuberculosis in which many other mesenteric glands shared. This suggests, he thinks, that the cause of the fever and pain in other children with tuberculous mesenteric glands whose appendices are normal, may be some absorption of toxins or bacteria from the bowel which the damaged lymph-nodes are unable to arrest without suffering. Short finds it is difficult to give directions for avoiding this mistake. The pain and tenderness and resistance, he notes, may be much less definitely located at the right iliac fossa than is usual in true appendicitis. On the one hand the symptoms of the latter condition are not always typical, and on the other, the inflammation of the tuberculous glands may be confined to the area of McBurney's point. There may be even a tender palpable lump, which is nearly certain to be taken for an abscess, but in this case the tuberculous lymph gland may be single, and it may be in the patient's interest to remove it, whereas if the lymph-nodes are widely involved nothing can be done, and the operation is therapeutically useless.

Wilensky's latest paper (with Hahn) following up his original report six years ago, establishes very surely that acute mesenteric lymphadenitis presents a clinical picture so similar to acute appendicitis that invariably the latter diagnosis had been made and operation performed. Abundant experience brought these writers to an ever increasing suspicion of lymphadenitis on several occasions, but exploration was done for fear of a possible appendicitis in any event. They believe that there is no clinical relationship between the two affections; that not all of the gland infections are tuberculous; that a history of previous cervical lymphadenitis is significant in diagnosis.

Acute Suppurative Arthritis of the Right Hip.—In 1881 Gibney put on record six cases illustrating mistakes made in diagnosis between appendicitis and disease of the hip. The chief error was in treating patients for coxitis when the appendix was responsible for the symptoms. His review was conceived largely with the chronic and subacute types and all of them were in children. Adults may come in for a certain share of the cases. Acute appendicitis is assuredly more dangerously confusing. Acute arthritis of the right hip has also been mistaken for appendicitis and abdominal operations performed. Avoidance of error depends upon painstaking observation and conscientious examination of each patient, especially children.

A striking example of the necessity of using care was afforded by the case of a ten-year-old boy sent in for acute appendicitis. Severe abdominal pain, vomiting, chills and high fever ushered in the attack; both legs were drawn up, the muscles of the abdomen were rigid, but there was no localization of the tenderness; the leukocyte count was 40,000; the patient showed a "shock" facies. In passing the hand routinely over the body it was found that the left hip region was exquisitely sensitive and swollen. Investigation showed an acute infection of the *left* hip-joint, with a fulminating osteomyelitis of the femoral head, to which the patient promptly succumbed in spite of immediate operation by a competent orthopedist.

Kelly cites a case of this sort, giving at first abdominal signs, but later developing tenderness and swelling in the right groin and thigh; incision evacuated a pint of creamy pus from an abscess in the thigh. I have had a similar instance, in which the pus was drained above Poupart's ligament.

A case beginning with pain in the right hip recorded by Christopher, which turned out to be multiple suppurative arthritis, was seen in consultation by an eminent surgeon, who "felt that it would be an injustice to omit an exploratory laparotomy because of the likelihood of the patient's symptoms being explained by a gangrenous appendix so situated on the psoas muscle as to cause pain on motions of the hip." A "catarrhal appendix" was removed, but the patient went through a long siege of arthritis and bone necrosis and finally recovered.

Many of these cases have sustained an injury, just previous to the attack, and this adds further perplexity. While attention is being directed to a possible trauma of the hip an acute appendicitis may be advancing. Remembering that appendicitis is an abdominal disease is the solution.

Suppurative Vertebral Arthritis.—Berry's report of a case of *suppurative vertebral arthritis* simulating acute appendicitis is very informing. Four days before admission a girl of nine tripped in a hole and hurt herself. Complaining of pain in the right hip, she became feverish, with rapid pulse and pain extending to the abdomen, to the right loin and right ilium, so that the attendant thought of osteomyelitis of that bone. On examination the whole right side of the abdomen was found rigid and tender; the tenderness extended from the lower ribs above to the great trochanter below and limited to the midline in front. The thigh was flexed slightly and internally rotated, the erector spinæ muscles were rather spastic, the hip-joint appeared normal. Pelvic examination and urine were negative. The anomalous physical signs led to a suspicion of osteomyelitis of the spine and this was carefully considered; but, in view of the good mobility and absence of tenderness on pressure over the spinous processes, it was excluded. A possible diagnosis of a retrocecal or laterocecal inflamed appendix with an abscess lying in front of the right kidney was made. Operation showed the appendix along the outer side of the cecum, adherent to it in its first part, but free in its distal portion and perfectly normal. The appendix was removed. The patient died three days later. Autopsy showed outside of the spinal dura, over the foramina of the tenth and eleventh intercostal nerves and vessels, a small quantity of thick whitish pus and where it lay in contact with the dura there was slight pachymeningitis, but no evidence of inflammation could be seen from the inner aspect. On stripping off the pleura on the right side, it was found that the anterior part of the capsule of the eleventh costovertebral joint had been eroded and that the head of the rib could be pushed forwards considerably by pressing the sternal extremity, showing that the remainder of the capsule had also been destroyed. In the intercostal space above and below, pus could be seen shining through the posterior intercostal membrane. On removing the eleventh vertebra with its attached ribs the middle costotransverse ligament was found partially separated due to tracking of the pus. The cartilage was eroded, but the head of the rib was intact. It is possible, says Berry, that a correct diagnosis might have been made in the early stage, although even the pain appears to have been located not at the seat of trouble, but mainly in the distribution of the tenth and eleventh thoracic nerves. As the area over McBurney's point is supplied by the eleventh nerve and the appendix receives its filaments from that nerve and possibly from the tenth, a diagnosis of appendicitis would have to be considered.

Mortality.—Optimistic authors are Muller and Ravdin, whose mortality in children has been as low as, if not lower than, in adults. They believe the death rate can be still further reduced by earlier differential diagnosis, mentioning the following simulating conditions that are important to separate: pneumonia, Pott's disease, gastro-enteritis, fecal impaction, and intestinal obstruction.

Drachter went so far as to say, given a proper diagnosis and a prompt operation, before peritonitis or pus, the death rate in children with appendicitis should be no greater but even less than in adults.

By far the largest number of observers have reported a *high mortality* from appendicitis in children. Brown concludes that it is apparently on the increase. He advises deferred operation at least in cases with peritonitis. Bolling's death rate under five years was 20 per cent. Beekman's was 35 per cent for the same period in his first series and 25.6 per cent in his last series.

Schlossmann's statistics show a high mortality in appendicitis of the young. In the nursling it is close to 100 per cent, in the second year 72 per cent. The average mortality for all cases between the first and second year is two to three times greater than in the adults. He says that Sprengel places the mortality in children at 33 per cent. Zimmerman, whose youngest fatal case was one and a half years old, had only an 11.7 per cent death rate. Prussian statistics give a mortality of 15 per cent in children, whereas in the adults it is only 5–8 per cent. The severity of the disease is attributed to the lessened resistance of puerile peritoneum to infections.

A recent review by Peterson shows a mortality of 9.7 per cent in forty-one cases under five years with no deaths in eighteen cases up to the third year. Without doubt this represents marked improvement. It means that we are overcoming some of the obstacles in the way of saving the infants and younger children suffering from this universal abdominal affection.

Various factors can account for the exalted death rate of appendicitis in children. Among them are: Difficulties in diagnosis, from failure to look for it, to consider abdominal pain seriously, to secure a satisfactory physical examination; the almost inevitable and universal administration of purgatives to children for practically every ailment due, either to what Moynihan called the "philo-cathartic propensities of motherhood," or to the still prevailing practice of some physicians, who when in doubt lead laxatives; the tendency of the appendix in the young to rupture early, probably because of its delicate structure and its relatively large amount of lymphoid tissue; the lack of localization of infection in the infant's peritoneal cavity, owing to a short, transparent omentum and weakened adhesive protection; lowered general resistance of the body to infection in children as compared to adults; absence of moral courage in those whose duty it is to give or to receive advice, seeing that the child cannot speak for himself. One or all of these reasons may exist in a given case.

Diagnostic Difficulty.—In the matter of diagnostic difficulty the physician who first sees the patient and the surgeon who may be called are equally responsible for riveting their attention upon a possible acute appendicitis even in the youngest infant, sick with suspicious symptoms. Howland has made two or three useful suggestions. "Children," he said, "be they ever so ill with pneumonia or other febrile diseases usually sleep for long stretches; but the child with abdominal pain will not sleep, and will not let anyone else sleep." Also in his experience assumption of the sitting posture without complaint by the child argued against appendicitis. His warning was never to omit the rectal examination.

In suspected appendicitis Wolf puts the small child on the floor and watches it as it runs toward its mother. The "psoas symptom" becomes evident while it is frequently not present in the bed because of the analgesic influence of the doctor's presence.

A satisfactory physical investigation can be made only by the use of tact and psychology. The examining physician must be an expert detective, using the subtlest art to approach and the gentlest manner to win the patient. Gaining the information without seeming to be seeking it is the keynote. Above all I subscribe to Christopher's admonition to "avoid a too boisterous 'Pollyannaism.' A quiet friendliness is the better plan."

Administration of Purgatives.—How to get away from the castor-oil bottle is another story. Undoubtedly this household purgative is the direct cause of many deaths from perforated appendices, and these disasters are most numerous in children. They must submit to its administration; responsible adults may refuse to take it. Fortunately it is now and then rejected by an already long-suffering stomach; but so often the dose is repeated. A report in the literature states that "the most usual cathartic, castor oil, was given with good results," but operation the next day "revealed a well localized appendicular abscess"—essentially a bad result. How many hundreds of times a day this procedure is being enacted over the whole world! In twenty-three records presented by Beekman cathartics, usually castor oil, have been given the children previous to admission and all of these showed ruptured appendices—nine with abscess and fourteen with spreading peritonitis. None of the unperforated cases received the purge. There were ten patients who died with diffused peritonitis; six of these had taken castor oil and two had been given frequent enemas. More recently, however, Beekman in discussing Peterson's paper said: "Vomiting is a common symptom in all gastro-intestinal conditions, and in the vast majority of cases it is not due to inflammation of the peritoneum but to gastro-enteritis, and it is therefore very easy for the parents or the family physician to give the usual remedy, castor oil, and I am perfectly willing to say that I think in ninety-five cases out of a hundred they are right in their medication."

It matters little who gives the cathartic, the effect is the same—to produce violent peristaltic movement and, if the appendix be acutely inflamed, rupture may be precipitated; if not, the bowels will act with violence, but no perforation will result—who can tell? Attempts should be made to establish a diagnosis before any therapeutic agent is employed.

Natural Conditions.—The tendency to early rupture, the lack of a localizing process, the lowered general resisting power, these it is impossible to change or to remedy. Knowing these natural conditions in the child, we should be on the alert to make the earliest diagnosis possible, and to advise the very soonest surgical interference, even sooner, if possible, than in the adult patient. Bolling feels that "late recognition of the disease, rather than rapid course and lack of bodily resistance, is the cause of high mortality"—wherein he narrows his factors down more closely than other surgeons. But perhaps he is nearer the truth; since matters of resistance and anatomical tendencies are unknown quantities, while the question of clinical recognition is a very practical affair.

Absence of Moral Courage.—Moral courage is just as essential here as professional knowledge. There is a greater inclination to procrastinate in the case of the young child than in grown people, chiefly from a natural sympathy for the helpless patient and an inner hope that "it may not be appendicitis: we will wait and see." That is often the hope deferred that maketh the patient sicker. Deliberation is necessary in many cases and hasty operation for insufficient cause will bring regret. But allowing a golden opportunity to slip by is equally disastrous. Mistakes will be made, and it is better to err on the side of operating unnecessarily and harmlessly upon many than to fail to operate on one case that might have been saved by timely interference. Six cases of pneumonia in Beekman's series of 145 were operated upon for acute appendicitis; also there were two cases of pneumococcus peritonitis mistaken for appendical peritonitis, and two cases of mesenteric lymphadenitis; an abscess mass in one case was diagnosed as intussusception.

Few will agree with Peterson when he says that "speaking generally, the diagnosis of appendicitis in children is easier than in adult life, as there are fewer things to be looked for." The majority of cases, he believes, undiagnosed go on to recovery. He hints at "a direct causative relationship between appendicular irritation and intussusception" and also between hernia and appendicitis, naming both of these in differential diagnosis among other conditions as: pneumonia, gastro-enteritis, pyelitis, pyosalpinx and an inflamed undescended testis. Referring to complications Peterson says that one should never feel satisfied with a diagnosis of measles or tonsillitis in the presence of pronounced abdominal symptoms.

Chronic Appendicitis.—One hundred cases of chronic appendicitis in children were studied by Mixter, who considers it a clinical entity, with definite pathologic evidence and remediable in 90 per cent of the cases by operation. He relies upon attacks of nausea and vomiting, abdominal pain, constipation, headache, anorexia and lassitude as the leading symptoms. Roentgenologic examination he found of value, but rectal palpation furnished no information.

Unquestionably if chronic appendicitis exists in the adult—and it does—its presence in the child must be admitted. Interpretation of its symptoms will, of course, differ widely in the two periods of life. The relation of certain clinical signs to a definite type of pathological change in the appendix can be demonstrated. In children the changes will extend to the mesenteric lymph glands, the liver, the pancreas, the kidney, as in older patients. We have previously given an example of the appendicular liver in a young boy.

Here is an instance of chronic appendicitis with liver infection in young children. Saathof and Lunkenheim make a report of three deaths from chronic disease of liver in the children's institute within one year. The patients, a girl of five years with atrophy of liver (nutmeg liver) and the boys, aged eight and ten years, with hypertrophy, presented symptoms in common: loss of appetite, progressive emaciation, acholic stools, icterus and the usual objective signs; also vague epigastric and umbilical pains. Autopsy showed enlarged mesenteric glands and spleen, the appendix, enlarged, swollen, chronically inflamed with adhesions. At no time were there any symptoms pointing to the appendix and it had never been suspected as part of the complication.

The Diseased Appendix as a Cause of Acidosis in Children.—The very first reference to this subject may be seen in a paper by Newton published in 1920 He spoke of the relative rarity of chronic appendicitis in children compared with the acute form and gave as his opinion that various vague disturbances in children were very likely caused by a "non-acute pathological appendix," not often thought of in that connection. Later he proposed the idea that "cyclic vomiting" and recurring attacks of what was called "acidosis" might be due in many cases to a diseased appendix. Suggesting his proposal to Gray, Newton was able to procure his coöperation in the radiological investigation. It was "found that in many of these there was distinct roentgen-ray evidence of disease, either then existing or which had resulted in a definitely abnormal appendix. When this evidence was found the appendix was removed and in practically every case a complete relief from the attacks followed."

Gray realized that "acidosis" in children may arise from other sources than chronic appendicitis and that it is not always synonymous with "cyclic vomiting." In his last report Gray lists six cases, relieved for more than a year. He notes, by the way, only one reference (previous to the work of Newton) to chronic appendicitis as a possible cause of cyclic vomiting, that of Comby. Since then, however, at least one writer has been aware of this syndrome. Mixter says: "Not infrequently there is the previous history of digestive upsets for years, which may have been diagnosed as acidosis, cyclic vomiting or fat indigestion, with no history of any well defined attack referred to the right lower abdomen."

The surgical aspect of this question, in collaboration with Newton and Gray, was largely in the hands of McGuire, who reported more than a dozen cases operated upon with uniformly gratifying results. His experience has led him to advise appendicectomy for recurring attacks of acidosis in children after hygienic and dietic treatment had failed and all other possible foci of infection had been removed. He places confident reliance upon a careful x-ray examination.

These observations by Newton, Gray and McGuire are of exceeding practical value. Looking back on many previous cases, one can trace these acidosis patients, some of whom died without a diagnosis and others came finally to an acute fulminating appendicitis which took them away while many recovered, if the crisis were recognized soon enough. For six years now our attention has been focused upon this condition and we have had occasion in numerous instances, with the assistance of pediatric consultation, to justify the relation of appendicitis to this troublesome complication in children.

From the opposite point of view D. P. Murphy looks upon *acidosis as a cause of acute abdominal pain.* His observation was made chiefly upon children, "in whom a previous diagnosis of acute appendicitis had been made," who showed distinct acetonuria and whose abdominal symptoms cleared up rapidly and completely from treatment of the acidosis alone. He pictures a typical case, with pain in the abdomen, a temperature of 100° F., a leukocytosis of 25,000, acetone in the urine and a sweetish odor to the breath. Operation was postponed, the acidosis treated and in forty-eight hours all symptoms had disappeared.

This may be a true deduction upon the cases reviewed. All acidosis attacks are surely not due to appendicitis or to any other intra-abdominal cause, but may present abdominal symptoms and thus confuse the diagnosis. Is it not fair to conclude, however, that, in the light of Newton's investigation, a diseased appendix is a frequent instigator of acidosis attacks in childhood, which tend toward recovery, but will recur over and over again until the appendix is removed? May not the cart be put before the horse? The subsequent story continued over many years will probably give the answer.

Most heartily do I agree in Murphy's suggestion that in all children with abdominal disturbance "it is very important to determine the presence and degree of acidosis." He says that by giving treatment to dissipate the acidosis an unnecessary operation may be prevented. He might go further and say that, after the acidosis has disappeared, continued study must be made to determine its cause, and the appendix may be the guilty party. This contribution is of value if it can be maintained that acidosis from other sources may give rise to pain in the abdomen.

Diagnosis.—The problem of appendicitis in the young child, as Drachter long ago remarked, is one of diagnosis. For it is upon a knowledge of its presence that any rational idea of treatment depends. And one is merely asserting an axiom to remark that early diagnosis and early operation mean a lowered death rate. Many mistakes are made and numbers of cases are overlooked in children. Roberson's feeling is that "the symptoms are so often misleading and irregular as to make an incorrect diagnosis somewhat excusable." How to overcome the diagnostic difficulties is the question. Diagnosis upon suspicion is the safest plan, guarding one's opinion by close perception and laboratory study.

Some *abdominal lesions* must be distinguished from acute appendicitis in childhood. Among these *intussusception* is important. This commonest form of intestinal obstruction in children occurs almost always in breast-fed infants under one year of age, a period when appendicitis is rarely ever found. The patients show a "shock" facies, temperature is not high, the stools are bloody, rectal examination shows the telescoping and a more or less sausage-shaped mass is felt across the abdomen. The latter has been mistaken for an appendical abscess.

It is also possible to have both intussusception and appendicitis simultaneously present in the same patient. In the case of a girl baby, of eight months, Hoppe encountered intussusception accompanied by acute appendicitis. The appendix was greatly swollen and inflamed; its tip was distended and of a dark bluish green color. Four inches of ileum was found invaginated into the cecum. This was released, and the appendix removed; recovery resulted.

Occasionally errors occur, but they are not of much moment because the treatment is operative in both instances. A case reported by Heckes was peculiarly puzzling. A baby of four and a half months, breast-fed, was admitted with persistent vomiting, blood and mucus from rectum several times a day, a high temperature and rapid pulse. The abdomen was distended and tender on the right side with a small lump on the right about the level of umbilicus. Diagnosis, intussusception. Operation showed the small and large intestines enormously distended, but no intussusception; instead there was a purple, inflamed appendix in a gangrenous state. No other abdominal condition. Appendicectomy was performed and recovery was smooth.

Operating in May, 1926, upon a three months' old infant for intussusception I found tightly engaged in the constricted mass a long slim appendix very dark in color, almost black. Its coats were intact and no inflammation was present. Having no time to spare in the operation, on account of the patient's serious shock, I did not stop to remove the appendix, but dropped it back in after releasing the intussusception and no harm came of it; for the patient made an excellent recovery and is now in perfect health.

Lymphoid hyperplasia of the appendix in children is considered by Smith as of sufficient importance to entitle it to a place among diseases of the appendix. It may simulate subacute or chronic appendicitis. The microscope reveals in these appendices, not an inflammatory process, but a hyperplasia of the lymphoid tissue, so constant and abundant in the appendix in the young. The youngest patient in the series of thirty-seven cases was five and a half years; 60 per cent of them were over ten years and under twelve and a half years, showing a greater frequency towards adolescence. The symptoms are very like those of an ordinary appendicitis, with the added character of frequent recurrence of sharp, short attacks over a long period. In some cases there was enlargement of the mesenteric lymph glands. Some authorities have looked upon lymphoid hyperplasia of the appendix as associated with the status lymphaticus. All the children were improved by removal of the appendix.

In the opinion of Battey, disorders of the *gastro-intestinal tract* play the largest part in childhood appendicitis. He considers appendicitis a well localized enteritis, for the former is often preceded by the latter. Personally he attaches great importance to increase of the polynuclear leukocytes in childhood, but finds rectal examination disappointing.

At the conclusion of his lengthy and valuable review, Christopher gives the following, arranged in order of their importance, as the most valuable points in the diagnosis of acute appendicitis in childhood: tenderness in the right lower abdominal quadrant, leukocytosis, rigidity in the right lower abdominal quadrant, abdominal pain. He notes that the diagnosis may be extremely difficult. Further he concurs in the generally accepted view that acute appendicitis in patients under five years progresses rapidly to perforation or gangrene, and is attended by a high mortality.

Thompson observes that in childhood it is not necessary to rule out acute gall-bladder and pancreatic disease or perforating ulcers of the stomach or duodenum in the *differential diagnosis* of appendicitis; but that it is essential to exclude pyelitis, acidosis, ileocecal adenitis, basal pneumonia, diaphragmatic pleurisy and Henoch's purpura.

One of the very difficult distinctions to make in children is that between *pneumococcal peritonitis* and appendicitis. It is always problematic unless there is a history of a recent pneumonia or pleurisy when pneumococcus infection of the peritoneum may be suspected. At least 50 per cent of the cases are diagnosed as appendicitis, for the onset may be similar, with pain and tenderness in the right abdomen. Pneumococcal peritonitis may be related to pharyngitis, otitis media and infection through the fallopian tubes in girls, in whom it occurs twice as frequently as in boys. In thirty cases of pneumococcal peritonitis in children a primary focus in the lungs was found in twenty-two cases. It was only from such association that I have been able to determine the diagnosis in the limited number of cases that have come under my observation.

A recent report by Dodds upon the value of Sgambati's test is suggestive. While he found it of no pathognomonic significance in all cases of inflammatory infections of the peritoneum, yet in the series of 177 cases the test was positive in every case of pneumococcal peritonitis, but in peritonitis secondary to appendicitis 50 per cent of the results were negative. Positive indications, however, were seen many times when no peritonitis existed and the reactive response was as frequent and as high in interval appendicitis as in acute diffuse peritonitis. The Sgambati test for peritonitis: A few drops of nitric acid are poured slowly upon urine in a test-tube; a blue ring is seen to form above the contact zone; if a little chloroform is added and the tube shaken a permanent ruby red color may be seen if the test is positive.

The benefit derived from appendicectomy in children harboring a chronically diseased appendix is often nothing short of miraculous. An ill-thriven, undernourished child will promptly begin to grow and may soon become an entirely different being. In a few cases the appendicular pathology may appear to be insufficient to account for the symptoms and the improvement. Harrenstein noted complete change for the better in a child who had been weak, listless, and sickly, and upon whom the operation seemed unnecessary, as the appendix was normal. He explains the benefit by the improvement in mechanical conditions. His study of fifty-seven cadavers convinced him that insufficiency of the ileocecal valve is responsible for much of the disturbance we have been attributing to chronic appendicitis. Attention to the stump of the appendix he thinks incidentally helps the working of the Bauhin valve.

This is illuminating in view of the observation by Oudard, previously noted (page 191) that faulty invagination of the appendix stump may produce intestinal obstruction by its encroachment upon the ileocecal valve. In the one case it is loosened, and in the other, tightened.

Treatment.—The management of appendicitis in children cannot be said to differ materially from that in adults. There are two or three particular points to stress. First of all, what may appear to be an early case in a child may really be a delayed one, on account of the usual tardy diagnosis. Drainage will be used more frequently and more freely in children, because of the low resistance of the peritoneum and its tendency to form pockets in distant areas. Moreover, children do not stand very well or very long the expectant-starvation plan, but operation, to be effective, must be done before systemic absorption has overwhelmed the septically susceptible patient.

Bolling asserts that there is no exception to the rule that treatment in children is surgical and the operation should be carried out forthwith. "Even surgeons who advocate delay in certain adults advise operation in similar cases in children." Seeger says that "with few exceptions, appendicitis in early life should be treated surgically at whatever stage the patient is seen."

There is every reason why the utmost gentleness should be exercised in surgical manipulations upon young children. A general tendency is noted among many operators to drain abscesses and desist without removing the appendix. In very desperate cases this may be necessary. As a rule, however, it is desirable and feasible to do an appendicectomy without adding to the danger. The type of incision is immaterial, certainly not any one form is to be used in all cases. The gridiron and the right rectus each has its advocates, as in adults. There is stronger reason for using the McBurney incision in children, even for the most acute cases, because, as stated by Seeger, it gives rapid and bloodless access to the appendix and necessitates very little manipulation within the abdomen. But the placing of the incision is of less importance than the recognition of certain simple principles of technic. The important element in the after treatment is the installation of fluids by the skin in the advanced cases. The rectal drip is futile in young children.

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CHAPTER X

PROGNOSIS

Prognosis, or knowing beforehand, may be defined medically as the foretelling of the probable outcome of disease. It is a more difficult and elusive art than diagnosis. It presupposes a knowledge of the disease as a whole and some experience in similar cases, and implies a prophetic judgment in regard to the personal elements, the complicating lesions and the various factors which enter into the relation of the patient to the malady.

Concerning the prognosis in appendicitis, it would be a sound statement to say that it depends upon the type of the disease. The outlook is quite different in the chronic or the subacute variety from that in the fulminant form; and manifestations in the adult differ from those in young children. In every case the prognosis should be guarded; for no one can tell when a chronic case may become suddenly acute or decide accurately before the abdomen is opened whether the appendix is ruptured or intact. In general it is perfectly evident that barring complications, the outcome would be favorable with an unperforated appendix, but uncertain if there were a rupture or gangrene of the appendix. Some of the very severest cases, on the one hand, will recover, if the relief comes in time to check septic absorption; while, on the other hand, occasional fatality will result from the toxi-infectious type of appendicitis, showing no local or diffuse peritonitis. As a rule, however, it may be axiomatically stated that the prognosis is always hopeful with an intact appendix and doubtful with periappendicular involvement, varying with its extent.

There is a natural tendency in appendicitis toward recovery from the attacks. Many will subside in forty-eight or seventy-two hours of their own accord, either by release of foreign contents from the lumen, checking of the infection by cell resistance or running of its course by a mild inflammation. The formation of adhesions, the walling off of abscesses represent Nature's efforts at cure, even when the disease has passed beyond the appendix itself. But adhesions, membranes and exudates formed in this way themselves constitute a pathological state and lead to complications and sequelæ. This is a reminder of a statement made by some one, that Nature's first attempts were always beneficent, pointing to recovery; but that her second attempts were often hindrances rather than helps, resulting in additional annoyance. How wise, then, it is to heed her first attempts!

Conversely there are attacks of appendicitis, occurring suddenly, showing no disposition to remit, but progressively active from the start, the fulminant form, sometimes resulting in perforations or gangrene after a few hours. There is no sign of subsidence; there are no stages. In my experience four out of five patients with this type have had previous attacks—mild, mayhap too mild for proper diagnosis, but nevertheless most of these fulminating cases are not first attacks.

Then, there may occur in an appendical attack the "treacherous calm," so graphically and originally described by Dieulafoy in 1899. In the very midst of the acute symptoms the fever leaves, the pains disappear, the patient seems better. It may be that ice-bags and opium have been used and they receive the credit for the improvement. Operation is postponed in the hope of gaining time, but complications occur and sometimes the operation is too late. The pathology is explained on the theory that the "passage of virulent microbes into the peritoneal cavity lessens their virulence." This may happen in the beginning. The temperature may fall and the suffering cease, but the facies remains. "The cloven hoof of peritonitis is stamped on the face of the patient." Real subsidence means the equal disappearance of all signs.

Since the prognosis depends almost entirely upon the time of operation it is well to say here that the first warning of Nature in appendicitis is the first attack and, once the diagnosis is established, the removal of the appendix at the earliest possible moment betokens recovery and permanent cure. Before operation, however, one should not feel safe in predicting the state of the pathology from the symptoms nor give too favorable a prognosis even in the very primary stages. In the later periods, when septicemia, peritonitis, or intestinal obstruction supervene, either with or without operation, the prognosis is always grave and usually fatal. Yet in this extremity rallying is possible, when too much is not done to destroy the natural tendency toward recovery.

But "never should the surgeon call for aid from beneficent Nature until he has exhausted his own resources," says Ashhurst, who impressively states the truth that there is no known means by which an infection limited to the appendix can be modified or controlled. Here is his further confession: "I am conceited enough to believe that I can recognize, as well as any one else, the occurrence of perforation or suppuration in appendicitis, but I frankly confess my utter inability to feel sure one hour that neither of these events will occur during the next, so long as an acutely inflamed appendix remains within a patient's belly."

Prognosis may generally be expressed in terms of mortality figures. From them can be gathered evidence in favor of or against certain methods in diagnosis and treatment. Mistakes in either of these directions will make or mar the outcome. It will be profitable, therefore, to think of the prognosis of appendicitis in the form of mortality and mistakes.

Mortality.—Attention has been drawn recently to what has appeared to be an increase in the death rate of appendicitis for the past ten years. The first gun was fired by Murphy in the following forceful words: "In looking up recently the hospital statistics on the results of operations for appendicitis, what mortality rate do you suppose I found? . . . The average hospital mortality rate is just a little over ten per cent! This includes appendicitis cases of all classes brought to the hospital for operative treatment. . . . When you know that in our best hospitals better than 98 per cent of all the acute appendicitis cases, including those with abscess and peritonitis are saved, and when you know that scarcely one out of a hundred cases of acute appendicitis operated upon during the first twenty-four hours of the attack is lost, think what the result must be in the other hospitals to make the general average so appalling! There is no excuse for a mortality rate of ten per cent in appendicitis. The rate is simply shocking. These patients did not die because of the operation—do not misunderstand me—they died in spite of it. They died in the hospital under a surgeon's management, but they died not so much because of any fault in technic as because of the fact that they did not reach the hospital in time for successful operation. Procrastination was the cause of death—the almost criminal cause. The initial symptoms of appendicitis are clean-cut and almost unmistakable. The later symptoms are equivocal and not to be relied on. The mode of onset of an attack of appendicitis is no clew to its probable course or complications. We can never tell in a given case what the next day may bring. Therefore, operate to-day! By operation we take the course of the disease into our own hands. By not operating we leave the case in the hands of a blind and often terribly cruel fate."

Quoting this at length in an important address Crook favored education of the people concerning the dangers of delay, placing the responsibility upon the attending physician and effecting a complete agreement between the medical men and the surgeons upon the management of appendicitis. It was found that the mortality figures through the year 1919 showed but little decrease.

McGuire commented on this situation by noting that Murphy's statistics included a large majority of interval cases and that they were from superior hospitals, leading him to observe that the mortality of acute appendicitis in the United States was still very high. McGuire's advice was: Educate the laity against giving purgatives, the family doctor in early diagnosis, and the surgeon in operating promptly. He would operate in acute abdominal conditions even when the diagnosis is not exact, which has caused some mistakes; but also many lives, otherwise lost, have been saved by this plan.

In 584 cases Bancroft emphasized the early operative results and showed the fallacy of waiting until abscess formation, when operation was not performed at the onset. He found the mortality no lower in the abscess cases than in those of appendicitis with free fluid, whereas in the circumscribed pus cases the after complications were much more numerous and serious.

Randall judged that the mortality of appendicitis was increasing faster than the rate of population. He gave the statistics of the State of Michigan. In 1913, there were 259, or 8 per cent, per 100,000 population, whilst in 1916 the death rate was doubled, *i.e.*, 521 or 16.8 per cent. These dropped to 14.98 per cent in 1918. He says the death rate of Michigan is twice that of England. He thinks it is increasing in the more civilized nations, and that the greatest mortality is between the ages of five and fifteen years. He further states that in endeavoring to reduce the mortality there must be more prompt diagnosis and operation; that the giving of purgatives before and after operation undoubtedly increases the mortality; that inexperienced operators consume too much time in searching for the appendix with too much handling and exposure of the intestines; that sudden, acute abdominal pains in children usually mean appendicitis; that the importance of diagnosing appendicitis from rigidity of the external oblique in the absence of rigidity of the right rectus muscle will further reduce the mortality.

An exhaustive study by Eberts and McKim of 216 cases of appendicitis operated on during two years ending June 30, 1920, shows conclusively that the unfavorable results were directly due to delayed surgical intervention. In the tabulated clinical history and results of treatment of these cases there were a few points which stood out with special distinction:

1. Of the acute cases, 44 per cent were perforated.
2. Wound infection developed in 95 per cent of the perforated cases, but in only 1 per cent of the nonperforated.
3. The perforated cases were in hospital more than twice as long as the nonperforated.
4. There were no deaths in the nonperforated, but 16.9 per cent in the perforated.

Besides delay in operating, purgation and morphia given are responsible for a large percentage of fatalities.

Reviewing the statistics of numerous authorities and his own cases Kahn concludes that surgery is the only treatment. Inasmuch as the progress of a given case defies prophecy, there is only one time to operate and that is immediately following the diagnosis. Reliable statistics show Kahn a mortality of 10 to 20 per cent. Sixty per cent are early cases in which the infection is within the confines of the appendix, and these have practically no deaths. Forty per cent of those operated are late cases where the infection has spread beyond the appendix and these cases give the mortality. The present high mortality can be greatly reduced by timely intervention, but early diagnosis is essential in order that early operation may be performed.

Discussing the postoperative mortality in appendicitis, Brown brought out the following facts: The mortality in England and Wales from 1901–1918 was 2,416 cases. In 1918 the mortality was almost double that of 1901. The period of childhood and early youth is the most dangerous, nearly one-half the total number of deaths occurring between four and twenty years. Operation during the first twenty-four hours is practically free from danger. During the second twenty-four hours the result is usually satisfactory, though there is some risk that the infection may have spread beyond the appendix wall. The increased risk of operation, especially upon children during the first week, after the time of election has passed, that is during the third, fourth, fifth and sixth days, is recognized by all surgeons. Figures of the Medical Society of London given some years ago showed that the death rate rose rapidly at this time from 2 per cent on the first day, 2.8 per cent on the second to 19 per cent on the fifth day and 22 per cent on the sixth day, subsequently falling to 8 per cent on the seventh day and 7 per cent on the eighth and thereafter continuing to fall. An operation during the second week, which usually consists in opening and draining a fairly large abscess, is attended by little danger.

This last statement may be true as far as the operation is concerned, but complications are likely to prove dangerous and it is running a great risk to wait long enough for an abscess to form.

Flint's study of 370 cases of acute appendicitis yielded a classification into three groups—inflammatory, gangrenous, perforative. Taking them together the mortality was 5 per cent. Earlier diagnosis and prompt treatment should bring all cases into the first group in which there were no deaths. Delay accounts for the larger death rate in the other types and Flint believes modern teachings and textbooks are chiefly responsible for it. All of his cases were subjected to immediate operation: 227 by appendicectomy and closure of the wound, giving three deaths—one gangrene, two general peritonitis; 124 by appendicectomy and drainage, with fifteen deaths—three acute obstructions, one empyema, three secondary abscesses, three general peritonitis; nineteen were treated by drainage only, with one death from general peritonitis. The postoperative management was much the same as Ochsner's preoperative plan.

The question was asked by Dugan, "Is the death rate from appendicitis increasing, and if so, why?" His answer from the literature for the two years previous would seem to prove that it had increased. He stressed the need for hammering again on "earlier diagnosis and earlier operation by a competent surgeon." The deferred operation in selected cases and the withholding of purgatives in the "acute abdomen" are advocated.

In a series of 5,488 cases of all types, with 327 deaths (5.95 per cent), reported by Deaver and Magoun, they state that the mortality has decreased practically 50 per cent during the previous decade (1914–1924). Some of this improvement they ascribe to general increase in knowledge of the disease and some to the expectant treatment of the diffuse peritonitis. Their highest mortality was caused by subphrenic suppuration and multiple abdominal abscesses.

Gatch and Durman operated on 262 consecutive cases of gangrenous appendicitis with a death rate of 7.2 per cent, but in 205 cases complicated by abscess it went to 9.2 per cent. Eleven of their nineteen deaths were due to peritonitis, on account, they opined, of purgation and extremely virulent infection. They do not advise expectant treatment.

Interesting figures are shown from a collection of 2,018 cases reported by Love. Of 221 patients operated on within twenty-four hours of the onset, the mortality was 0.9 per cent; of 341 cases treated on delayed lines, it was 3.5 per cent; of 1,677 cases in which immediate operation was performed (including the 221 in the first group), it was 5.8 per cent. This gives support to those who believe cases of appendicitis should receive individual consideration as against the somewhat popular idea that "all cases should be operated on as soon as diagnosed." Love finds that a localized abscess carries a lower death rate than restricted or general peritonitis; the former shows a relatively high mortality and the latter a notoriously high mortality, both because of virulence of infection, lowered resistance and inopportune operating. Operations done from the third to the fifth day have a high mortality, because the patient is in the "negative phase" of immunity; analogy is seen in thyroid surgery and the management of infected wounds immediately after infliction. Mortality is high in the first decade of life, for reasons which were stated in the chapter on Appendicitis in Children.

Fifteen hundred cases of appendicitis were classified by Hörnicke, particularly in reference to the time of their admittance to the hospital. In the forty-eight hour stage complications were rare and the mortality was 2.2 per cent; from the third to the fifth day, it was 4.6 per cent, conservative treatment being the rule and giving better results than the radical; after the sixth day in the late stage, the treatment varied according to the condition, and the results were: Abscess cases operated on gave a mortality of 6.7 per cent, diffuse peritonitis cases showed 27.4 per cent mortality in the operated cases and 67 per cent in those treated conservatively. The total mortality in the cases treated by operation, 1,178 in number, was 1.6 per cent and in all of the fifteen hundred cases, 3 per cent.

A table prepared by Duggan from the records of the Boston City Hospital, giving the mortality rate by the year from 1895 to 1922, shows a progressive increase in the number of cases treated and a marked decrease in the deaths. In 1895–1896 the mortality was 20.7 per cent: for 1921–1922 it was 3.1 per cent. At one period, 1916–1917, with next to the largest number of cases, it was only 1.8 per cent. The last ten years' records show a definite decrease from 6.8 per cent down to the 3.1 per cent as given above.

In 1924 Bratrud reported on slightly over seven hundred operations for acute appendicitis up to 1917. Of the 362 cases operated on in the first forty-eight hours none died, although many were gangrenous or perforated. In the second series of 350 cases seen after forty-eight hours, there were seventeen deaths. Of these seven were moribund on admission and all had received cathartics; five patients died of liver abscesses, two in spite of operation; four died of general peritonitis after drainage; one operated on the fourth day died of general peritonitis on the seventh day in spite of a double enterostomy. A review of these seven hundred cases with a 2.5 per cent mortality gives evidence in favor of the Ochsner plan of treatment compared with operative statistics from other hospitals in which cases were operated on at any and all stages. Since resuming work in 1920 Bratrud has had three deaths in over one hundred cases during four years.

A personal communication (August, 1926) from Bratrud furnishes me with the recent statistics from Professor Key's clinic in Stockholm, His results with acute appendicitis in 1925 at a Municipal Hospital are as follows:

Simple appendicectomy, 153 cases—no deaths
Appendicectomy plus drainage, 14 cases—no deaths
Circumscribed peritonitis, appendicectomy plus drainage, 20 cases—3 deaths:
  woman, 54 years—pulmonary emboli
  man, 62 years—gas phlegmon
  man, 38 years—sepsis
Peritonitis circumscribed plus postoperative prolapse of the intestines, 1 case —died.
Circumscribed peritonitis, incision in 3 cases—no deaths.
Free peritonitis, appendicectomy plus drainage, 17 cases—2 deaths:
  man, 74 years—pyelitis, 3 weeks postoperative
  man, 41 years—pulmonary emboli
Free peritonitis plus ileus, 4 cases—no deaths (gastrostomy used to supplement appendicectomy in one case)
Subphrenic abscess, 1 case—died.
TOTAL NUMBER OF CASES: 213; TOTAL NUMBER OF DEATHS: 7
(less than 4 per cent)

The coöperation in Sweden between the surgeon and the practitioner is very close and the means of transportation are very good so that emergency cases reach the hospital, as a rule, at an early hour.

A review by Adams of the mortality figures on appendicitis in the leading hospitals and poor law institutions in the district of London up to 1922 shows that the hospital cases are diminishing slightly since 1912 while the infirmary figures are increasing. His explanation is that the general practitioner, realizing the emergency types in appendicitis and the lack of empty beds in the hospitals, rushes his patients into the infirmaries where he knows they will be admitted without delay.

Sherren contends that the death rate from appendicitis is not decreasing despite the wide special knowledge of the disease. The number of deaths from appendicitis in England and Wales during 1923 was greater than that of any previous year. In late cases he adopts the conservative course of delayed operation because the mortality is lower.

The loss of life from appendicitis steadily increases, according to Rowlands. In 1923 there were nearly three thousand deaths due to the disease in England and Wales, three hundred more than in 1913. In America he finds there were over eleven thousand deaths in 1920. The mortality is not yet under control. The fatalities are mostly in the young, more than 50 per cent under twenty years. Timely operation would save 99 per cent. Earlier recognition of minor attacks which precede the graver ones is necessary; and there are usually warnings. Delay is the one great cause of the deaths. Purgatives and homely remedies used before the doctor is called present the most serious problem. Operation done within twenty-four hours gives no mortality, as a rule. Delayed operation in the postponed cases gives the best results in Rowlands' hands. Under the conservative "starvation" treatment he had 3.5 per cent of mortality; in those operated at once, the death rate was about 10 per cent. There should be no temporizing with children or very old people.

No better record is to be found than that of Field, who reported 1,124 cases operated on by himself with five hospital deaths. One case with fecal fistula died several weeks later at home and could be included without great detriment to these excellent statistics. The operations were performed in eleven different hospitals, but the majority in two institutions. The acute appendicitis cases in all stages, including general peritonitis, were 561 in number; of chronic appendicitis there were 144; and 419 appendices were removed in the course of other abdominal operations. The deaths were all in the first series, all perforated cases, with either abscess or general peritonitis. As a rule operations were done as soon as the diagnosis was made. A few exceptional cases were put upon the expectant plan. In his 182 patients with acute appendicitis operated upon within forty-eight hours after the onset the mortality was 2.2 per cent.

The mortality in Muller's series of 101 cases of acute appendicitis was 4.9 per cent. This is near the average reported from other hospitals, and in larger collections of cases. These cases occurred in one year's time. They were divided as follows: thirty-eight cases of simple appendicitis; twenty-two cases with purulent fluid; forty-one cases with perforation or gangrene—nine with abscess and thirty-two with diffuse peritonitis. Delayed operation was found sometimes to be of value, not only in the way of quieting peristalsis, but also of exhibiting stimulants to the patient and introducing fluids under the skin.

Hotz' statistics show the low mortality of patients operated on the first day (1.2 per cent) or the second day (2.4 per cent) or in the interval, and the high mortality (9.6 per cent) between the seventh to the tenth day.

Davis finds the mortality very high in certain types of streptococcus infection in appendicitis because once the bacteria escape from the confines of the appendix they spread over the entire abdomen with frightful rapidity. "Since the epidemic of influenza in 1918 it seems that this type is more frequent and may be due to the incidence of new types of organisms of the streptococcus group."

From his own experience of 327 cases combined with reports of 11,400 cases from thirty-five hospitals located in eight states, Warnshuis finds the average mortality of operations in acute appendicitis to be 4.23 per cent: in chronic appendicitis, 1.68 per cent; of the two combined, 2.9 per cent. He discusses the factors which influence mortality. In the matter of diagnosis he arraigns careless examinations, too meticulous insistence upon classic signs, slavish dependence on blood-counts; in operative technic he counsels incision and stump treatment according to the individual operator's best judgment, cautions against rough handling of viscera, advocates free drainage when needed at all and believes the early removal of drains increases the mortality.

A. M. Willis presents a rather dejected estimate of the present day mortality in appendicitis. Upon figures furnished by the Bureau of Vital Statistics he concludes that, along with that of other important diseases, the death rate of appendicitis has increased about 31 per cent in the past ten years. He holds the mortality of appendicitis compiled from 1921 statistics to be 14.4 per cent in one hundred thousand population while in 1901–1905 it was 11 per cent. This rate does not exist "in the large surgical clinics from which . . . optimistic reports emanate," but presumably occurs in the practice of "a constantly increasing number of surgeons in this country with little experience in . . . grave surgical procedures." Such operators rarely report their results and evidence of their accomplishment generally is lacking. From the statistics in the registration area it develops that the annual death rate from appendicitis equals the combined death rate from ectopic pregnancy, pyosalpinx, gall-stones, and surgical diseases of the pancreas, spleen and the thyroid gland. It almost equals the mortality from gastric and duodenal ulcer, intestinal obstruction and gall-stones. Willis figures that "if the rate of ten years ago had been maintained there would have been a saving of over 3,000 lives annually." He mentions some of the factors which he believes are concerned in the increased mortality: occasional operators attempting cases beyond their capacity; rigid adherence to the rule of removing the appendix in all cases; lack of uniformity in teaching and in opinions regarding the conservative and radical types of interference. As a constructive recommendation Willis proposes a commission to effect a "standardization of the methods of treatment."

Comment.—Felicitations are due Willis for his challenge. The more forcefully such statements are brought to the front, the fewer lives will be lost. He did not, of course, mean any injustice to the smaller hospitals or to the less distinguished surgeons. The Bureau of Vital Statistics gathers its reports from an area under supervision of state and municipal registrars, whose records are more or less conscientiously kept, but which naturally cannot be scientifically accurate. In many states practically no autopsies are done and in none, so far as known, are they compulsory. Faulty diagnoses, therefore, are common. Unfortunately in the statistics quoted there appears to be no analysis of the diagnostic features or of possible delay in operating. Neither is there any mention of how many patients were operated on or how many died without operation. In some way these omissions may be offset, but they must have an important bearing upon any estimate of the surgical prognosis of appendicitis. As expressed in the textbook by Osler and McCrae, for instance, "it would be interesting to know how many of the 11,321 fatal cases in 1920 in the United States had been operated upon and at what period."

In the hospitals situated at the larger centers records are more carefully kept, the patients are referred earlier and are more willing to have prompt operations without interference from family and friends. Every one, however, must agree in the strictures upon the untaught operators who are misled into thinking that appendix operations are free of risk to the patient from the technical point of view. As Willis remarks: "The removal of a normal appendix from a slim young girl may present no serious difficulties even to our occasional operator; the removal of a perforated appendix in the presence of peritonitis from a corpulent man of 50 is a different story. And yet the rank and file of the profession seem imbued with the idea that 'all appendicectomies are simple.'"

Not all will join in his plea for more "standardization of methods." Perhaps there is already too much cut-and-dried method—doing a given thing in a given case at a particular stage. If ever perfect results will be obtained, they must come, we submit, through judgment educated in certain principles, through the attainment of the ability to apply a general rule to an individual case. Perhaps Murphy was right again when he said that the story of appendicitis should be rewritten every ten years.

The latest report upon the mortality is that of Guerry. He presents the truly remarkable record of 2,959 personal operations for appendicitis with sixteen deaths, or a mortality over all of only 0.54 per cent. Of these, 1,241 were of the chronic type and none of them died. These can be eliminated from a consideration of the mortality record. The appendix was removed during other operations 366 times with one death, a mortality of 0.27 per cent. There were 688 cases of acute appendicitis without rupture, one death, a percentage of 0.15. In 570 cases of ruptured gangrenous appendices, showing localized abscesses small or large, there were four deaths, a mortality of 0.7 per cent. Of eighty-five cases of diffuse peritonitis operated upon at once seven died, a mortality of 8.2 per cent; in 123 cases of diffuse peritonitis in which the operation was deferred, the deaths were two, a mortality of 1.6 per cent. This is the striking point of the report. Guerry insisted "that on the handling of these cases the question of the mortality rate largely rests," and he is "more firmly established to-day than ever before in the belief that the secret of the mortality lies in the deferred operation as applicable to this particular group of cases." He gives Ochsner credit for "genuine insight."

It may be interesting now to go back over twenty years and compare some figures of that period with those of recent date outlined above. One year's work in appendicitis by Deaver, consisting of 566 operations from September 1, 1902, to September 1, 1903, gave a mortality rate of 5.3 per cent. This approximates closely his later figures. Of the general peritonitis cases 31 per cent died and of the abscess cases 12 per cent. Dennis in 1904 reported 119 cases with only two deaths (0.16 per cent), both occurring in desperate cases, (*a*) from empyema in an alcoholic and (*b*) from abscess of the lung secondary to subphrenic infection. In a discussion of his two thousand operations for appendicitis from 1889 to 1904 Murphy stated that owing to improved teachings, earlier surgical interference in acute cases and more frequent operations in the interval his mortality had been reduced from 11 per cent in the first hundred cases to 2 per cent in the last hundred. Still later, about 1910, textbooks on the practice of medicine gave the average mortality as about 14 per cent.

So that the mortality of appendicitis, like that of many another disease, has seemed to run in cycles. It is questionable whether its virulence varies, which is the case with certain infectious and contagious maladies, but at least there are some unmeasurable elements that may account for the conflicting reports. Among these are personal agency, social conditions, inherent delays, professional character, a turn of chance. Undoubtedly many more of the advanced cases are saved to-day than ever before; but also both in the furor and the ease of operating at present many are rushed into surgical interference that well might wait. Although the great majority of even the most desperate cases are saved by careful technic, it is unfair to the surgeon to put all such burdens upon him alone, whatever his skill and judgment may be capable of.

It is plain that we are here in a jumble. Unqualified statistics mean very little, except to the one who reports them. He sees them in the light of the types of cases and the methods used. He is able to interpret them, to classify them according to his individual judgment and personal observation. If the operations for chronic appendicitis or any form of disease in an unruptured appendix are included, almost any operator can show an infinitesimal mortality. Barring accidents all patients of this type should recover. It is the complications that kill—both those which exist before operation and those which arise afterward. It is computed that complications occur in 10 per cent of all cases. The successful surgeon, therefore, is the one who recognizes the complicating lesions, when present beforehand, and manages them wisely at the time or when they occur following operation.

Reduction of mortality will be accomplished, then, not so surely by rescuing last minute cases from certain death by brilliant technic, as by prompt removal of the appendix at the onset of its inflammation. It is the universal testimony that when the infection is limited to the appendix its extirpation is attended practically by no mortality. Far better results will be secured from operations done in the early safe period by a mediocre surgeon than could be obtained by the most capable operator in the late cases made dangerous from complications. *"There would be no percentage of deaths from appendicitis if every case commencing with acute pain and developing tenderness and rigidity of the abdomen and quickening of the pulse were operated upon within twelve hours"* (Rutherford Morison).

Mistakes.—When mistakes occur, either in diagnosis or treatment or both, the mortality results are seriously affected and thereby the prognosis. Interpretation of statistics must be based upon inquiry into the diagnostic means employed, the presence or absence of complications and the complete conduct of the cases. The outcome of a particular case cannot justly be forecast without some knowledge of how it was handled from the beginning and what was its later disposition.

Errors in diagnosis have been mentioned previously, difficulties in differentiation have been presented. These will continue to happen. There is no human way to prevent them. Luckily it is more often that operations are performed for appendicitis when other ailments are present than the reverse. So the situation usually is overdone and not underdone. But, when fatalities result from overlooked conditions, the mortality rate could be charged against diagnostic incapacity rather than lack of operative skill. It would be a very poor prognostician who could not see that a neglected patient with appendicitis plus peritonitis will likely die and an extraordinarily good one who could tell in all early cases whether the patient has or will have a ruptured appendix or may surely get well.

In 255 cases of acute appendicitis studied by MacLaren to determine the causes of death following operation, none was denied surgical interference. There were thirteen fatalities. Two of these, he thought, might have had a better chance under the deferred plan, but years before he had had four cases die from the waiting policy. More than 50 per cent of the deaths were late, not from peritonitis, but more from prolonged suppuration; a few died from mechanical obstruction, but more from septic ileus. MacLaren did not lay down any specific rule to follow. He occasionally postponed operation when the attack was subsiding, but interfered at any time if the patient was progressively growing worse.

Bearing upon the prognosis is the question of a hasty diagnosis. This is strongly scored by Gallagher, who thinks "with the advent of hospitals in the smaller places and the arrival of the modern doctor who can always remove an appendix, the number of appendicectomies is probably increasing. We are taught to get the appendix out before it ruptures and in our feverish anxiety to do so, no doubt we often get it out before it has become inflamed, and thereby overlook the real cause of the patient's trouble which may not be surgical at all." He then goes on to record eight instances in which mistaken diagnoses of acute appendicitis were made, the conditions being found to be respectively: smallpox, cerebrospinal meningitis, pyelitis, pneumonia, ureteral calculus, pregnancy, bleeding ovarian cyst, "moonshine" alcoholism.

As attested by Burrows, "the majority of misadventures in appendicitis arise in connection with the diagnosis. . . . The most crafty of experienced practitioners will be deceived now and then. The careless and inexperienced will err perpetually."

Granting the uncertainty of diagnosis and the innumerable sources of error, is it any wonder that the prognosis in appendicitis is inconstant, subject to doubt? At all times it must be guarded.

Morbidity.—In *chronic appendicitis* the mortuary list does not concern us. But involved in its prognosis is the morbidity percentage. The results to be expected depend here also upon intelligent diagnosis and the amount of disability the patient shows. There is not yet complete satisfaction with the ultimate efforts following removal of the appendix in the chronic cases. Invariably in the unrelieved patients it will be found that faulty diagnosis was the cause. We are still unprepared to make a perfect diagnosis; perhaps some day all difficulties may be overcome. In the report of Stanton, noting postoperative end results in 110 patients, he lays great stress on the fact that practically without exception the cured cases of chronic appendicitis have all presented a constant group of symptoms, while this syndrome was absent in the uncured cases.

Recurrence of Symptoms.—The cause of recurrence of symptoms after removal of the appendix was investigated by Lawrence. His paper is based on ninety-seven cases showing, in percentage figures, the symptoms of intermittent pains in the right lower quadrant, vomiting, nausea and disturbance of the function of the bowels over a period of a year or more. Forty-two per cent were operated on for chronic appendicitis, but none was completely relieved by the operation. The chronically inflamed appendix is probably only one evidence of a pathologic condition of the lower bowel, which consists in a mechanical obstruction to the proper evacuation of the intestine. Due to the inability of the intestine to empty itself properly, there results a low-grade inflammation, not only of the appendix, but of the cecal region from which the appendix arises, and in many cases of a considerable portion of the large intestine. While removal of the appendix, therefore, may insure the patient against perforation of that organ, it does not relieve the general situation, and in many cases, if the low-grade inflammation of the intestine is eliminated, removal of the appendix becomes unnecessary. In 34 per cent headache and vertigo were relieved when the stasis was corrected.

Errors in Diagnosis.—Bettmann's study of "diagnostic errors leading to uncalled for appendectomy" permits the following interpretative conclusions: Operations for chronic appendicitis do not yet yield a satisfactory proportion of cures, owing to errors in diagnosis; aside from the relapsing type, a particular group of symptoms suggests chronic appendicitis, but not with reasonable certainty; in from 40 to 50 per cent of the unsuccessful operations, right iliac pain, present beforehand, remains for months or years after the operation; two-thirds of the failures are in cases that have not been adequately studied before operation; too many constitutional disorders are overlooked and removal of the appendix is often attended by serious after results.

"The most brilliant results known to surgery have followed appendicectomy for chronic appendicitis," says Bigelow; but he agrees in the general opinion that "the symptoms are not always or even commonly well defined" and that "the diagnosis is not to be made with glib assurance." A certain brand of neurotic female makes an operative recovery but, in Bigelow's words, haunts "the surgeon's office for weeks to come with symptoms only a little worse, until he wonders if mortality is not really better than morbidity." As he remarks, however, it is not fair to charge the mistakes of judgment made in such a patient as this against the excellent results to be obtained in cases properly studied and selected.

In a personal communication E. H. Pool draws certain conclusions from observation of Jewish girls in a hospital clinic. His views are summarized in the following report: From the follow-up records of the Second Surgical Division of the New York Hospital for the past ten years (1916–1926) it was found that the cases operated upon for chronic appendicitis showed a symptomatic failure in approximately 12 per cent. In analyzing these failures 125 cases were studied. These poor results were mostly in young Jewesses ranging from sixteen to twenty-four years of age; in girls who were working in sweatshops, whose homes were in poor hygienic condition, whose food was made up largely of sweets and sodas, whose physical exercise was practically nil, whose bowel habits were most irregular, and whose occupation predisposed to pain on the right side, since many of these girls were operators and used the right foot in working the machines. These patients would come to the hospital complaining of indefinite pain in the right lower quadrant. After appendicectomy they were free of symptoms for a short time and then the pain occurred as prior to appendicectomy. In the study of these postoperative failures, a most careful history and physical examination were made; the teeth and all foci were inspected as to sources of infection. Diet, regulation of bowels, and definite methods to combat constipation were carefully discussed. The urinary tract and the genital organs were investigated by specialists. The gastro-intestinal tract, lavage, study of stomach contents, barium series, inflation of large bowel and cecum, as suggested by Bastedo—all these tests were done and it was seen that by diet, by creation of better habits, by better hygienic conditions, by change of occupation, more could be accomplished than by appendicectomy. Accordingly this type of patient, with all the symptoms and signs suggesting a chronic appendicitis, is now first referred to the medical clinic and the social service department, and the operations have been much less frequent.

Comment.—From a statistical review of 630 cases treated between 1919–1924, Paus concluded that in cases of appendicitis children should be operated upon at once, the risk of undertaking an operation, even if the diagnosis should be uncertain, being less than the risk of missing the right moment for surgical intervention. It is better now and then to remove a sound appendix than to run the risk of a case of peritonitis. He thinks old people should be operated upon at the earliest possible stage; but if the disease has reached a rather late stage before medical assistance is sought he generally refrained from operation.

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CHAPTER XI

TREATMENT

Perhaps no better prologue for the final scene could be exhibited than to quote the opinions of two of the world's greatest medical clinicians upon the management of appendicitis. As long ago as 1896, Georges Dieulafoy gave voice to these wise words: "There is no medical treatment for appendicitis. Medical treatment simply causes loss of time. It is obvious that the patient can be relieved by injections of morphia, applications of ice-bags to the affected region, and other soothing measures; but do not let us be mistaken as to the efficiency of these means. Too often they lead us to believe in cure, when they only mask the symptoms. In view of this fictitious improvement, we speak of typhlitis, or appendicular colic, and prophesy recovery; but yet the patient dies for want of proper surgical intervention."

Just as positively and as sanely Osler and McCrae assert: "Gradually the profession has learned to recognize that appendicitis is a surgical disease. In hospital practice the patients should be admitted directly to the surgical wards. Many lives are lost by temporizing. The general practitioner does well to remember—whether his leanings be toward conservative or radical methods of treatment—that the surgeon is often called too late, never too early. There is no medicinal treatment of appendicitis. There are no remedies capable in any way of controlling the course of the disease."

In the first edition of his textbook (1892) Osler said: "The medical treatment of appendicitis can be expressed in three words—rest, opium, enemata. . . . I would protest most earnestly against the indiscriminative use of saline purges, which have been advocated under a total misapprehension. . . . The profession has yet to learn the lesson that perforative appendicitis is in more than three-fourths of all cases a surgical affection and perhaps the most important function of the physician, under whose care the disease always comes at first, is to say whether the case is suitable and when the operation should be performed."

Contrast the latter paragraph with the one preceding it. The period of thirty years intervening between the two observations proves that the profession did learn the lesson gradually, if, indeed, they have yet completely mastered it. It is of some interest to notice that in the earlier edition Osler gave as synonyms for appendicitis, the terms typhlitis and perityphlitis. At least, these words have now all but disappeared from our nomenclature.

In times far gone there might have been extenuation for the policy of delay, for the nursing of patients through attacks, for treatment by medicine and rest and local applications. Before the days of aseptic surgery it was even permissible to wait for the formation of an abscess, which could be treated by evacuation and drainage. Many of these cases recovered. But some of them died and the complications in the living patients were often disabling. And a large proportion of those under medical management failed to recover either their health or their lives. To-day there is no excuse, alibi or apology to justify indecision, delay or any treatment by medical means once the existence of appendicitis has been established beyond a reasonable doubt. Nonoperative treatment has no place in appendicitis, unless it be the use of those measures to get the patient in order for operation, the preliminary or preparatory methods. And even then, as little as possible should be done both in the acute and the chronic cases. It is my confirmed opinion that those patients who have had the least "preparation" come through their postoperative course most comfortably.

At all events there is no reason for any consideration here of the medical treatment of appendicitis. I am aware that many physicians believe in the dietetic, mechanical, and symptomatic management of chronic appendicitis. I am also aware that some still temporize in the acute attack and undertake to "freeze it out" with an ice-bag. To any such it might be mentioned once more that once appendicitis, always appendicitis, and that the acute attack is only a call for help, a knock at the door. The disease, *appendicitis, is a "going concern,"* producing its damage just as much between as during attacks. To get over the attack is not an end of the affair, but a temporary lull, allowing an accumulation of pathological material for further exacerbations. It is a comparatively easy matter to get credit for "curing" an attack, or even several attacks, of appendicitis by any plan of nonoperative treatment; for, as previously explained, the general tendency of most invasions is toward recovery, and whatever means were employed will be said to effect the result. But, to rehearse our dictum, *the attack is not the disease;* it is merely a symptom-complex, evidence of deep and real pathology.

A noninterferent treatment is justifiable in certain cases of acute appendicitis, which for various reasons may not be submitted to operation. It may be that patients cannot be operated on because of extreme senility, serious disability, dangerous diseases elsewhere in the body, or inaccessibility. In such cases, or for any other good reason against operation, the patients are to be put to bed; permitted nothing by the mouth until the signs are subsiding; given enemas, if needed, but no purgatives; and relieved of pain by local means or anodynes, as indicated. These are the measures to employ and this is as far as one can go in the so-called medical treatment of appendicitis.

The treatment of appendicitis is wholly surgical. Only by an operation can the offending lesion be forever removed and the patient cured of the disease. At times one must be content with doing less radical and less curative measures in the presence of complications or delayed attention. But surgical operation is the rational procedure and none other is to be thought of in comparison to it. The matter of appendical therapeusis, therefore, may be summed up in a discussion of *when to operate* and *how to operate.*

Whether to Operate.—Before taking up the study of the occasion and the method of operating let us pay our respects to those who may be still considering *whether to operate.* This question may relate to the expediency of the moment or to an advisable period in the future. There can be no escape from the conclusion, based upon views expressed in the preceding paragraph, that it were better for every appendix to come out if it be diseased, both when the diagnosis is established and even when it is suspected. By this plan more lives would be saved, more patients restored to health, than by any process of deciding if this or that case should or should not be subjected to operation. There is, in fact, no acknowledged means of distinguishing invariably at the beginning those which need immediate operation from those which may be deferred. It follows, then, that the question of whether to operate cannot be intelligently proposed.

It must be granted, however, that circumstances can arise to cause postponement or even to prevent operation altogether—conditions such as consent of the patient or family, failure to secure proper arrangements, the existence of positive contra-indications which may be more serious than the disease, and other unforeseen contingencies. Never should it be understood, however, that the necessity for operation has vanished or that the apparent mild character of the attack has caused abandonment of the procedure. Such injudicious admissions are productive of harm, leading to an unfortunate state of mind in the patient and his friends, and often to later disastrous consequences. Once the diagnosis is clear, it is a steadfast rule that the appendix should be removed and the inquiry, whether to operate, should always be answered in the affirmative, be it a matter for immediate attention, which is the safer action or for some supposedly more convenient season.

The patient is generally willing, if not demanding, to be operated upon, when suffering pain, as he does in the early stage, and at all times may submit readily, if the danger of delay is carefully explained to him. There is more reluctance when the pain has subsided gradually and naturally or from the occurrence of perforation or gangrene. But in this day and time it requires the minimum persuasion for getting patients to the operating table in acute attacks of appendicitis. The responsibility falls largely upon the general practitioner, for it is he who first sees the great majority of the cases and whose advice is usually depended on. It can be truthfully said that for the most part the practitioner is meeting this responsibility; unquestionably this is the rule with the more enlightened class of physicians. Theirs is the duty of making the diagnosis, the all important factor, of calling the surgeon when he has made it, and of contributing his moral support of the operation and his active consultation in the after treatment, when possible. If the practitioner happens to be one who "does his own surgery," a double dose of responsibility is his: to decide, to direct, and to execute. "Whether" to operate, then, affords its own reply; it is superseded by the momentous questions of "when" and "how" to operate.

WHEN TO OPERATE

Obviously it would appear to be a normal corollary of the foregoing remarks to say that operation should be performed in acute appendicitis when the disease is recognized—and that at the earliest possible moment. This is and should be the general guide to follow. But there are exceptions. To say that every case of appendicitis should be operated upon as soon as the diagnosis is made or as soon as the patient is seen would leave no room for human judgment. Without qualification this iron-clad rule would work mischief. Beside the extenuating conditions heretofore mentioned, it becomes necessary to analyze the diagnostic points and to mark critically the stage at which the patient comes under observation.

When the diagnosis is beyond doubt and the patient is seen early, delay is not permissible; for, at this period—on the average during the first thirty-six hours in adults—the pathologic process usually is limited to the appendix and the operative procedure is all but as safe as in the interval between attacks. This might be denominated the ideal time for operation in acute appendicitis. Following upon this stage—not all attacks show definite stages—the outbreak may recede and disappear in a few days, or it may proceed to perforation or gangrene. In the former contingency operation could safely be done, if seen at this time; when the latter conditions supervene, the period has arrived, which, as expressed by Maurice Richardson, is "too late for the early operation and too early for the late operation" and the judgment will be seriously taxed to decide what course to pursue. Generally it is best to perform the operation at this stage, provided there is no widespread peritonitis and provided certain definite principles of technic are followed. Over a matter of three to five days from the onset in such cases this period of uncertainty remains.

If now a step farther is taken, there occurs a spreading peritonitis, becoming general unless something is done to check it. For many years, say up to 1903, operations done at this stage furnished the largest percentage of deaths. Almost all of the cases were lost. There was a continued aggression of the peritonitis; systemic absorption of toxins ensued; no sort of drainage sufficed. There are those who yet contend that it is correct judgment to operate upon all cases of acute appendicitis the moment they are observed regardless of the stage of the disease or the condition of the patient. My impression, however, is that the number of such surgeons is decreasing. They claim good results and their actions cannot be gainsaid. Clever they must be in overcoming certain difficulties in technic and in the choice of their cases. Many surgeons are applying some phase of deferred operative scheme to these "on-the-fence" cases and report lower mortality rates and ease of manipulative work.

Ochsner Treatment.—It was precisely this phase of appendicitis that inspired Albert J. Ochsner to devise the preoperative method which has been known generally by his name. In 1902, he made authoritative announcement of a mode of managing certain cases of acute appendicitis, which he had "employed since 1892." As early as 1900 he reported 248 cases operated upon with eight deaths and at that time proposed his method for controlling peristaltic motion. He applied this plan particularly to those cases coming under observation, representing an acute perforative appendicitis with beginning diffuse peritonitis in a patient who is almost hopelessly ill, who has an anxious expression, abdominal distention with rigidity, a temperature of 103° F., and a pulse rate of 130. These cases belong to a class in which immediate operation then gave and now gives an especially high death rate. Ochsner's plan as first outlined depended on certain physiological principles which warranted the following conclusions and directions:

"1. Peristaltic motion of the small intestine is the chief means of carrying the infection from the perforated or gangrenous appendix to the other portions of the peritoneum, changing a circumscribed into a general peritonitis.

"2. This can be prevented by prohibiting the use of every kind of food and cathartic by mouth, and by employing gastric lavage in every case in which there are remnants of food in the stomach or in the intestines above the ileocecal valve, as indicated by the presence of nausea, vomiting or meteorism.

"3. The patient can be supported by the use of concentrated predigested food administered as enemata not oftener than once in four hours and not in larger quantities than four ounces at a time.

"4. This form of treatment, when instituted early, will change the most violent and dangerous form of acute perforative or gangrenous appendicitis into a comparatively mild and harmless form.

"5. Cases of perforative or gangrenous appendicitis, with beginning general appendicitis, can usually be carried through the acute attack safely with this method.

"6. In all cases of this class gastric lavage should be practiced to prevent the absorption of decomposing material from the alimentary canal.

"7. In cases of doubtful diagnosis this form of treatment should always be employed.

"8. This treatment will prevent a large proportion of the most troublesome complications and sequelae of appendicitis, such as ventral herniae, fecal fistula, extensive adhesions, etc.

"9. The patient should be permitted to recover fully from his acute attack before an operation is performed, except in cases encountered within the first thirty-six hours after the beginning of an attack or in case of the formation of a superficial circumscribed abscess.

"10. It often requires but a small amount of any kind of food to change a harmless circumscribed into a dangerous diffuse peritonitis, "11. The treatment does not protect the patient against a subsequent attack.

"12. It does not contra-indicate the removal of a diseased appendix before the septic material has extended beyond this organ.

"13. It is indicated in all intra-abdominal conditions in which it is desirable to prevent the distribution of septic material by means of peristaltic motion.

"14. The laity should be taught to stop feeding and giving cathartics to patients suffering from intra-abdominal diseases."

In devising this plan Ochsner predicted and produced 90 per cent of recoveries in a type of case that gave previously about the same percentage of deaths. It cannot be denied that he had hit upon a method of controlling a progressive peritonitis, rendering it safe for interference. For a full decade discussion of this treatment waxed warm, pro and con, and even at the present time remnants of the debate are found here and there. The problem has more or less settled itself in that some form of deferred operation—absolute or modified—is practiced by almost every surgeon who sees cases at the critical period of spreading peritonitis. Not many operators, perhaps, adhere rigidly to Ochsner's original hard and fast rules, but practically all observe in some way the principles he laid down.

About twenty years after his first statement, to be more specific in 1921, Ochsner spoke again, outlining the following revised plan:

"1. Place patient in bed, elevating the head of the bed 18 inches.

"2. Cocainize the pharynx thoroughly with a 4 per cent solution of cocain, permitting the patient to swallow a small quantity repeatedly.

"3. Make gastric lavage with water at 110° F.; repeat this in case of nausea or vomiting.

"4. Apply a large dressing to abdomen, held in place by abdominal binder, for immobilization and to prevent meddlesome manipulation.

"5. Give absolutely no food—not even the slightest amount of milk or liquid nourishment by mouth.

"6. Give no cathartic of any kind and no large enemas.

"7. Give 500 c.c. of normal salt solution (to which 50 c.c. of glucose and 1 to 2 c.c. of deodorized tincture of opium have been added) in the form of Murphy's proctoclysis by the very slow drop-method.

"8. Repeat this after a rest of two hours.

"9. Give 1/4 grain of morphin and 1/150 grain atropin hypodermically in cases of severe pain, and repeat this as necessary.

"10. Continue this until patient has been normal for at least four days.

"11. Then give commercial beef tea in small quantities, later broth, later strained gruels, later strained soups; do not give milk until a week or two after patient is apparently well.

"12. Do not give cathartics at any time.

"13. Keep patient on liquid diet until you can do the operation with perfect safety.

"14. In case an abscess forms open under local anesthesia."

The fourteen points here enumerated in detail are set forth verbatim for comparison with the fourteen points of the original method. In the main the essentials of each pronouncement are the same. The last list includes additionally the Fowler position (elevation of the head of the bed), advises the continuous proctoclysis, sets a limit of four days of normal temperature before food is to be administered and does not specifically counsel waiting for convalescence from the acute attack before surgical interference may be permitted. In fact by the advice to keep the patient on liquid diet until the operation can be done with safety it is implied that only a short time should intervene. Ochsner counted on approximately 98 per cent of recoveries from his own experience of the foregoing plan—an 8 per cent improvement over his former report.

The details of the plan as expressed by its inventor are given here both in his first and last published words on the subject, in order to clear the atmosphere of doubt. The Ochsner method has been woefully misunderstood. It is plain that Ochsner himself proposed it only for those border-line types of cases, the Richardson-formula cases—"too early for the late operation and too late for the early operation," as he quotes this epigram more than once in the first edition of his book. He did not advise the waiting plan ever in the beginning of the attack of appendicitis or at any time during its course unless peritonitis were present or imminent. He never hesitated even to open at once circumscribed abscesses occurring late, if they were walled off.

Also, he never used his method in cases at the extremes of life, expressing his views as follows: "There are two classes of patients in whom this form of treatment is not so satisfactory as it is in all other classes, namely, the very old and the very young. Very old patients do not bear confinement in bed well, no matter what their condition may be, and they do not prosper generally on rectal feeding. In these cases one is compelled to choose between two evils, and whichever is chosen one usually wishes it had been the other. In children it is difficult to perform gastric lavage, they are likely to struggle and injure themselves while this is being accomplished. The same is true of administering rectal feeding. Moreover, the omentum in small children is not sufficiently developed to act as an efficient protection. It is consequently wise in these two classes to operate whenever the patient's condition indicates that he will probably recover from the operation."

More than all, Ochsner never intended his treatment as a *substitute* for operation but as a *preparation* for it. This was the crux of his hypothesis. This was also the stumblingblock for unbelievers. For, immediately upon the original announcement of the method, it was seized upon by many as a nonoperative procedure to be followed in all acute attacks of appendicitis, even from the onset, in order to avoid operation. The noninterventionists were happy in a new, temporarily secure evasion; some practitioners gloried in pleasing their patients by "starving out the appendix"; now and then a surgeon fell into the idea that he could by this plan carry the patient over to a protected period, when the operation might have been just as safely performed in the first twenty-four hours. Also, the plan was incorrectly applied to localized abscess cases, easy to open and drain without danger and even in suitable cases often persistently protracted beyond the sane limit.

The truth is that, while the Ochsner treatment is useful in any case of acute appendicitis, to give rest to the affected parts, to prevent "distribution of infectious material" and to allay pain, yet its real value, as stated by its originator, lies particularly in that class of cases "in which there is already a beginning general peritonitis." In the opinion of many, with whom I agree, this is its principal if not its only field. In cases of lesser degree, where operation may have to be postponed for several hours or a day or more, the Ochsner principles can be carried out as preliminary to operation. There are some surgeons who pay no attention to the method; there are others who follow it to an extreme degree.

Behrend rather naïvely stated that the Ochsner treatment is no doubt valuable to those who understand its application; but that he never used it and had a mortality of less than one per cent.

Of one thing we are sure, that in modified form it has allowed us to delay operation with successful issue in cases which we formerly rushed to the operating table at once, as emergency cases, night or day, with generally a high mortality in consequence. We are further convinced that the Ochsner treatment has markedly reduced the death rate in the spreading peritonitis cases, which by any other plan have always yielded the greatest percentage of fatalities.

But it has been said that Ochsner's method has done much harm. There is nothing wrong in its conception and its proper use. The fault lies in its abuse, its unintelligent application, its employment in unsuitable cases. After all these years it seems impossible for certain physicians and surgeons to conceive the essential points of the treatment and to use it with reason. Critics have no right to condemn a plan which they have not followed in faithful detail or which they have carried out when it was not indicated. No defender of the Ochsner principle, however, can fail to admit that its application is limited. Its author did not advocate it for the majority of cases of acute appendicitis, but rather for a small minority: the special type which has already been described.

Dugan so understood Ochsner and thinks that this minority should be getting smaller rather than larger. He further observes that very careful selection of cases for the "starvation" treatment is necessary; that it cannot be given properly without a trained nurse, preferably in a hospital; that the technic is complicated; requiring good surgical judgment and careful observance of detail; that it has saved many lives, but its misinterpretation has also cost many lives.

Of thirty replies to Hardt's questionnaire, twelve approved of the Ochsner method and eighteen disapproved. Nine of the eighteen, however, did employ the method in practically moribund cases. Hardt himself reserves the treatment for the desperately ill patients, those with extreme distention, rapid pulse, cyanosis, and occasionally a case is saved, when immediate operation would be fatal. He finds one serious objection to it: that the general practitioners, particularly those who refer their cases to the surgeon only as a last resort, will feel justified in treating all their cases by the deferred plan and thereby produce disastrous results.

With emphasis Grant condemns the Ochsner treatment, or perhaps the application of it, in most acute as well as mild cases, blaming it for an increased mortality from needless delays. He recognized no substitute for immediate operation in this disease at any stage, and believes that rest, starvation, and salt solution do little or nothing to mitigate the pathological process, while the resisting power of the patient is diminished. Ochsner's comment upon these statements is as follows: "Statistics of insurance companies show there are practically no deaths in appendicitis operated before the end of the second day of an acute attack, or after the tenth day. It is in cases coming to the surgeon after the end of the second day, and before the end of the tenth day, of acute appendicitis in which the starvation treatment if properly applied, will save an enormous number of lives."

Without conceding an excessive importance to Ochsner's treatment it is enough to say that its rational employment has been a life-saving measure and that dissatisfaction with its results or fatal consequences following its use have come about either through inability to comprehend its principles or to careless execution in its technic.

Murphy's Methods.—A few years after Ochsner had been using his treatment John B. Murphy promulgated certain principles of managing acute appendicitis cases. It was in 1904 that Murphy published his conclusions based on his experience with two thousand cases of appendicitis. In 1908, he again discussed the matter very frankly. After vehement insistence upon early operation he raised the question: "Should we operate in the second stage, during the increasing or spreading inflammatory process, which may mean anywhere from the second to the fifth day?" He proceeds to explain: "In this stage we may have the circumscribed abscess around the appendix, an active inflammatory process of the neighboring tissue or organs, or the early pathologic changes of a circumscribed or general peritonitis. We often find the temperature and pulse high, meteorismus, intestinal paralysis, and acutely infected tissues, with manifestations of severe intoxication at this stage. These patients will not stand extensive manipulations. They are already fully burdened with the toxins, and this intoxication must not be increased or the patient will be sacrificed. Shall we operate? Yes; but the operation must be a limited one; that is, simple opening of abscess and relief of pus tension in the infected area with the removal of the appendix, if it be accessible and easily amputated." The least possible separation of recent or old adhesions and a minimum of trauma to infected tissues are emphasized. In the more advanced cases, "where the patient is apparently overwhelmed with the intoxication from a circumscribed or diffuse peritonitis or inflammatory process," Murphy would content himself "with making a single incision in the abdomen and relieving the pus tension by the insertion of a large drainage-tube *without irrigation, without sponging,* and *without manipulation* of the tissues." In 90 per cent of his cases at this second stage Murphy removed the appendix, but felt sure that if its removal had been attempted in the other 10 per cent, exhibiting severe, systemic sepsis, they would have had a fatal ending. He held that the extent of the operation should be governed by the amount of constitutional infection rather than by the degree or character of the pathological changes. In five years' work Murphy "had forty-seven cases of perforative diffuse general septic peritonitis operated in the active stage with but two deaths, and neither of these from peritonitis." The after treatment consisted in placing the patient in the semi-sitting position, prohibiting water by mouth, and administering large quantities of normal salt solution by continuous rectal infusion. For the first of these suggestions Murphy is indebted to Fowler; for the second, to Ochsner; the third is his own, though partly derived from the Ochsner treatment. Murphy talked of "getting in quick and getting out quicker" and preached the doctrine of "pus under pressure is absorbed." His wonderful surgical judgment coupled with his rare manipulative skill and gentle touch, enabled him to obtain his marvelous results. His powerful pleas for action and against delay had a widespread influence. Undoubtedly he set a salubrious pace and prevented many patients from being consigned to senseless delays and fatal issues. Many operators with less manual facility than Murphy (alas, how few equaled him!) could in no wise attain such brilliant results as he, and this was the weakness, if it could be so called, of his plan.

But being a combination of the best points of other procedures, Murphy's method worked well and his ideas are still in vogue. The Fowler position, the Ochsner starvation, the Murphy drip may be used in any case at certain periods of the attack with satisfaction and success. One of Murphy's most important suggestions was his demand that patients with diffuse peritonitis coming to the hospital be transported in a half-sitting posture and be kept in that position during the operation. One of the few inconsistencies of his treatment is his statement that "mild catharsis should be induced with small doses of calomel, beginning eight hours after operation." Scant justice is done Ochsner's method by Murphy. He refers to it as a "non-operative treatment of appendicitis," and considers it applicable in cases (*a*) where the surroundings are such that operation is impossible, (*b*) in patients who cannot withstand the shock of an operation, or (*c*) when no competent operator is available. A very brief and inadequate account of the plan is given, another inexplicable misapprehension of Ochsner's ideas.

The Murphy system is admissible in cases where the Ochsner method is not to be considered, in children and in old people; it is also to be used in cases not progressed to the general peritonitis stage (much discrimination is needed here) and in those cases, few in number, not benefited by the starvation plan but responding better to a combined method. There are patients unquestionably more safely handled, first, by evacuation of pus according to Murphy's masterly method, and later put upon the Ochsner treatment for temporary improvement or going through a real convalescence. Beyond cavil, Murphy made a definite contribution to the surgery of appendicitis.

The question of when to operate in acute appendicitis can be decided only upon an individual basis. Not only is the particular case to be considered, but also the time at which it first comes under observation. Whether one should operate at once, the natural course, barring complications, or defer operation for any reason, will depend on the stage of the disease, the patient's general condition, the operator's choice of method suited to his skill. There are possibilities of success or failure in any direction, but the study of each patient's problem in the light of experience is the only satisfying recourse.

There are some cases in which whatever one does is wrong. Decide as we may, fatalities will occur. Such a degree of pathological destruction can be reached in a few instances that it cannot be overcome. These cases will die. A patient with diffuse peritonitis may be carried over under the starvation plan and then either operated upon before actual subsidence takes place or delayed too long, so that death takes place from stirring up the local process or from a fulminant toxemia. Another may be submitted to an apparent timely operation, only to succumb to complications, such as intestinal obstruction, septic pneumonia or subphrenic abscess. Still another patient not very ill and with a localized mass may be operated upon immediately when seen between the second and fifth day, with very little handling of tissues followed by efficient drainage, and then die of septicemia or peritonitis. An example of each of these three alternatives occurred in my practice during the past twelve months, the only cases ending fatally in that period, and each was treated in a different manner. It is truly a difficult problem to predicate the pathology even in the simplest case and to choose the safe procedure in every instance. The amount of systemic absorption before the operation is the strongest factor in the fatalities and very often this cannot be measured beforehand. In addition to this the extent of the local pathological process may be so great as to preclude recovery. From these late cases a few deaths will arise, and will continue to appear until, by unanimous consent, early operation becomes the universal and unalterable custom.

HOW TO OPERATE

The question, "how to operate," can be answered best by the individual surgeon according to his own opinions, tastes and predilections. While there are marked differences in the smaller matters of operative procedure the general vergency is toward uniformity in technic. Certain fixed principles are essential. These have to do with the management of a case from the beginning, with the orders given beforehand, the conduct of the operation, the after care. Safety is the prime consideration. For its accomplishment the trend is toward simplicity of technic. Fewer errors occur in simple manipulative processes than in those of complex nature. The more we omit the multiplicity of detail and bring surgical technic down to an irreducible minimum of simplicity, the greater will be our reward in the ease and number of recoveries. Granting a case, the diagnosis confirmed, the examinations made, and the operation indicated, it is in order to proceed with the several steps.

Preparation of the Patient and the Field of Operation.—In some cases there is no proper time or opportunity for preparation. When the appendix is on the verge of rupture or in a fulminating type of attack, it is often imperative to get the patient to the operating table forthwith and any sort of preparatory treatment is out of the quesion. Perhaps purgatives and enemas were already given. At any rate these are not now permissible both for lack of time and for the harm they may do. The only preoperative attention indicated here is the local skin preparation, to be done either immediately on admission or after the patient is anesthetized. It has been my observation that patients admitted and operated upon as emergencies, with little or no preparation, as a rule have less postoperative discomfort from gas and nausea than many others who have been through the routine preliminary method. An obvious reason suggests itself in that the unprepared patient is free from excitement of peristaltic motion and not subjected to that "emptiness" which is associated with intestinal gas.

But, whenever practicable, it will not be amiss to have an enema given to the patient, provided the operation is not scheduled within three hours, and to attend to the field of operation at the same time. Two doses of bicarbonate soda, 30 grains, three hours apart, may be administered as a safeguard against acidosis; the patient is encouraged to drink freely of water. In subsiding acute cases and in the typical subacute cases, which may be carried overnight, the foregoing measures are continued as directed.

The skin of the abdominal wall is prepared by dry-shaving, rubbing in some oil-extracting substance like alcohol, ether, benzene or gasoline, and painting by an antiseptic preparation, such as tincture of iodin, mercurochrome, picric acid, acriflavin, etc. The employment of these agents and their strength percentages will be governed by the customs of different surgeons. It is important that the antiseptics be spread evenly over the whole abdominal surface and beyond its edges, since it may become necessary to extend the incision to distant parts and to make stab wounds for drainage at different points.

Anesthesia.—It is not within our province to enter into a broad discussion of the question of anesthesia in operations for appendicitis. Suffice it to say that each operator will use his own judgment or perhaps accede to the desire of his patient in the choice of the anesthetic. General anesthesia under ether, nitrous oxid or ethylene is the custom, and ether is given in the vast majority of cases. It may be preceded or accompanied by the other two: or they may be administered, each alone, under certain conditions.

By requests or for particular reasons local anesthesia may be used. It is not suitable for the acute cases with marked abdominal tenderness and rigidity, demanding much separation of adhesions or handling of inflamed parts. In the hyperacute type with purulent peritonitis, infiltration of a local anesthetic will readily permit a small incision, evacuation of the pus and the insertion of a drainage tube.

The chronic cases of appendicitis, especially in subjects with thin-walled abdomens, lend themselves very well to a local anesthetic, as far as the mechanical technic is concerned. But it must be understood that with this type of anesthesia no proper exploration of the cavity can be made and, with this left out, the story of chronic appendicitis is incomplete. When it is possible to exclude all other sources of trouble, except the appendix, its removal under local anesthesia is feasible and advisable when indicated or requested. Tuberculous patients, in whom general anesthetics may be contra-indicated, yield easily to infiltration anesthesia for appendicectomy. (See Chapter VIII.)

Methods of local anesthesia to be employed in operations on the appendix differ in no respect from those for similar types of operation. The preliminary hypodermic administration of anodynes, such as morphin and hyoscin, add to the effectiveness of the anesthesia. Thorough infiltration of the anesthetic solution, both into and under the skin (using novocain, or procain, or apothesin, or butyn in low percentage, with a few drops of adrenalin to each ounce), injection of any nerves exposed in the wound, avoidance of traction or rough manipulations—these are essentials for success in local anesthesia. The appendix may be handled directly under local anesthesia with practically no pain, unless it is pulled upon. In some circumstances the cecum should be disturbed as little as possible. The appendix can be delivered and amputated without evisceration of any abdominal organ.

Local anesthesia, however, is not the method of choice in very acute cases of appendicitis, although of necessity operations now and then are done in that way. Bevan believed that it was not the best method to adopt in the usual case, notwithstanding that he had just removed skillfully an acutely inflamed, gangrenous-tipped appendix under novocain-infiltration anesthesia in a man of eighty years, who also had a heart lesion and a sarcoma of the sternum. His patient experienced some pain because it was necessary to exert traction on the cecum on account of adhesions; but he was careful to inject novocain solution into the mesenteriolum before attempting to bring the appendix out. The succeeding steps of the operation were painless.

Incisions.—There are three types of incisions commonly employed for operating in appendicitis. They are:

1. The *oblique or "gridiron" incision,* usually called the McBurney incision, after the surgeon who devised it.

2. The *right rectus incision,* sometimes referred to under the names of Lennander, Edebohls, Deaver, Battle, Kammerer, Jalaguier, and others.

3. The *transverse incision,* attributed variously to Elliott, Chaput, and Davis.

Each of these incisions has its proper uses and indications; each has its more or less definite limitations; each has its advocates and opponents (Fig. 40).

1. The incision introduced by McBurney in 1893 was the original muscle-splitting incision, so-called because it separates the muscles in the direction of their fibers and does not necessitate cutting them across. It is said that L. L. McArthur had previously employed this incision. For ease of performance, perfection of closure, and permanency of healing, it cannot be excelled. As ordinarily performed the incision is supposed to have its center over McBurney's point, but as a matter of practical importance it may be placed in an oblique direction anywhere in the right iliac area. By palpation under the anesthetic or by interpretation of the signs one is enabled to place the incision where it will serve best to expose the appendix to view. It is well not to go too low for fear of damage to the internal abdominal ring, nor too high, so that it is difficult to reach the base of the appendix normally placed. Beginning to the right the incision is made obliquely downward, almost parallel to Poupart's ligament, going first through the skin down upon the external oblique aponeurosis. This is split in the direction of its fibers,

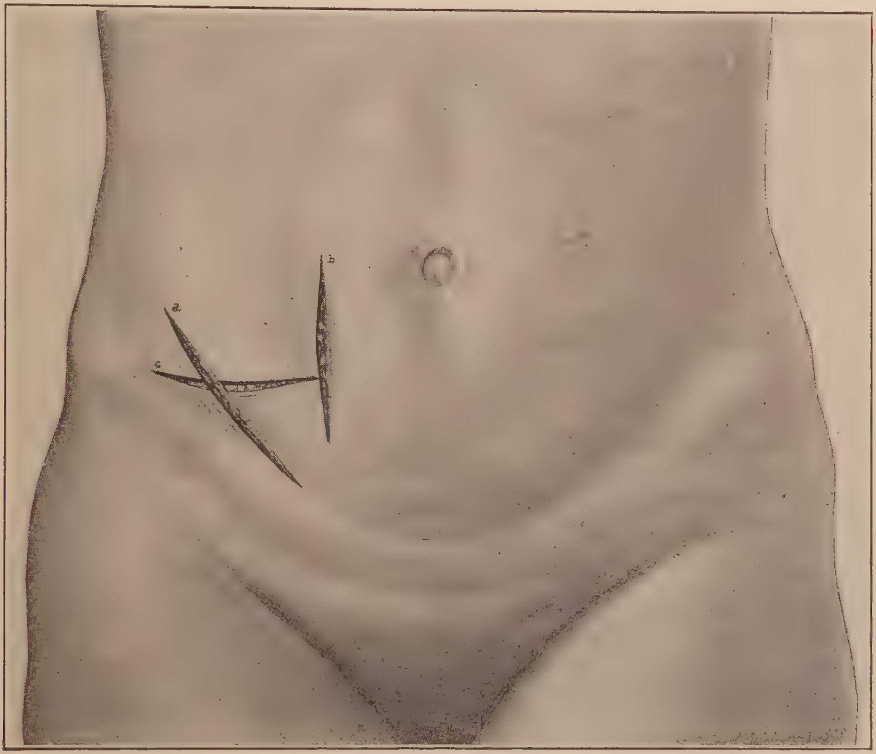

FIG. 40.—THE THREE INCISIONS IN COMMON USE; *a*, MCBURNEY INCISION; *b*, RIGHT RECTUS INCISION; *c*, TRANSVERSE INCISION.

the same as the skin, and held apart. The internal oblique muscle is then brought into view, running about at right angles to the external oblique, and its fibers along with those of the transversalis are bluntly parted in that direction. Retraction allows the peritoneum to be picked up and divided in the same general direction as the skin incision. The abdomen is now opened. If the hemostats used to pick up the peritoneum be left in place, one on each side of the incision, postoperative suture of the peritoneum may be done more easily. Closure of the wound is accomplished in our hands by suture of plain catgut on the peritoneum, of interrupted chromic gut on the internal oblique, of continuous chromic gut on the external oblique and of interrupted silkworm gut on the skin.

Objection has been made against the McBurney incision on the ground that it cannot be enlarged after it is once made without cutting muscles or fasciæ transversely. This criticism is not well founded. The incision may be enlarged either upward or downward by cutting along the junction of the internal oblique with the fascia of the right rectus muscle, turning the muscle flap outward and dividing the peritoneum in the same way. The other layers are not disturbed. All can be restored to their original positions by suturing as usual, first closing the peritoneum, then sewing the fascia connecting the rectus and internal oblique up to the transverse separation of that muscle and finally closing in the regular fashion. Repeatedly have I used this technic of extending McBurney's incision and always have I found it satisfactory for operative purposes and secure in its after results for the wound.

It has also been held that the McBurney incision should be restricted to the clean acute cases of appendicitis and for all types in children; that some form of right rectus incision should always be made in adults for drainage cases and in all chronic appendicitis patients. This would narrow the employment of the gridiron method very definitely. As far as my work is concerned I regard the McBurney incision as the most universally useful of all. Even in the suppurative types I have found it perfectly expedient either for drainage at the outer-middle or lower angle or for loose closure and the placing of a drain through a stab wound at some other point. If there is any case in which I am not keen on making a McBurney incision it is that of a chronic appendicitis with a doubtful diagnosis and with downright indications for exploring the upper abdomen and the pelvis. In such a case the right rectus incision is more efficacious.

In acute appendicitis it is not always possible to tell whether an incision will open up a clean state of affairs or whether pus will be present. If a McBurney incision were reserved for the nonsuppurative cases only, its employment could never be surely advocated. As a matter of fact this type of incision does not stand in the way of the operation in acute appendicitis nor of drainage in the after treatment.

Gatch and Durman say: "With increasing experience we have used the McBurney incision almost to the exclusion of all others." Their results showed its striking advantages. Out of 262 cases operated upon, 229 had the McBurney incision. Of the eleven cases who died of peritonitis, seven were operated upon by the McBurney route and four by right rectus or midline incision. Of the McBurney incision cases five had general peritonitis and two did not, so that in only two cases could there have been a possible discrimination of infection at operation. The McBurney cases had far less trouble and experienced a shorter convalescence than those who had other incisions.

In ninety-seven cases out of one hundred and one acute cases of appendicitis Muller used the McBurney incision. He preferred it to the right rectus incision because it rendered the appendix more accessible and caused less exposure of the small intestine.

In one hundred cases of acute appendicitis Wolfson and Morse used incisions as follows:

Gridiron	95 cases
Right rectus	4 cases
Midline	1 case

Drainage was required in sixty-one cases. One death occurred: a boy six years old with a gangrenous perforated appendix, who developed a left-sided abscess, which was opened through a left gridiron incision, and died twenty-four days after operation from ileus. These operators direct especial attention to the value of the McBurney incision; noting that it gives ample room for almost any procedure, that through it the distance to the ileocecal region is shorter than in any other approach to the appendix, that it is made easily and closed quickly, that intestinal evisceration is all but impossible and incisional herniæ very rare. They express surprise—and I join in the expression—that surgeons disregard or view with disfavor the McBurney incision in acute appendicitis. The objection that it gives limited vision and restricts movements, making operation more difficult, is annulled by the advantage of the trained finger and by restraining the operator to the contaminated area away from the danger zone.

In 259 operations for acute appendicitis by Truesdell, the McBurney incision was made 238 times, the right rectus fifteen, and the remainder unrecorded. He advocates this incision enthusiastically in all cases of early acute appendicitis and in the majority of late cases, for the following reasons: It offers the most direct approach to the appendix in most cases; it is strong, rarely breaks down entirely, is followed by very few incisional hernias; it requires little separation of limiting adhesions; it affords ready manipulation through a small opening.

Bancroft does not find much to choose from in the different incisions, but regards the McBurney as preferable to the right rectus, giving a shorter hospital stay.

2. Longitudinal incision beside the semilunar line, through the right rectus muscle, or into its sheath and drawing it aside has been in vogue from the

beginning of appendicular surgery. The several names attached to this variety of incision came about from modifications of the technic suggested by different surgeons, who curiously enough were working independently but almost simultaneously. It will not be necessary to go into the details of their particular methods. The general idea that seemed to prevail was to open the right rectus sheath, retract the muscle inward, and to enter the abdomen through the middle of the posterior sheath, transversalis muscle and peritoneum, all in one. The length of the incision can be made as desired and extended at will. It is a most practical plan. For all chronic cases, in which it is necessary so often to explore or operate upon the upper abdomen or pelvis, it is the method *par excellence;* in the former case the center of the incision being placed one inch above the umbilicus and in the latter one inch below it. It should be adopted in all cases of uncertain diagnosis and of complicating lesions elsewhere in the abdomen, present or suspected.

It makes no difference whether the skin be incised in a straight, curved or diagonal direction, or whether this corresponds with the line of the right rectus muscle. Some advantage is obtained by making the incisions in each layer at points which do not match, so that the abdominal walls are not weakened. Deaver's modification, which he calls the "simple incision," passes lengthwise "through the outer half of the right rectus muscle." He speaks of it as "easy and rapid of execution," capable of being made any size, affording "ample drainage facilities," and "not more likely to result in hernia formation than any other incision." This is a direct incision and obviously more suitable for cases that have to be drained than the other methods, which require retraction and replacement of the rectus muscle. It is, therefore, more widely applicable because it can be used likewise in the chronic types.

Valid objection may be made to Deaver's incision on the ground that it is bloody. Splitting the fibers of the muscle causes hemorrhage and necessitates ligatures. But this objection obtains in all types of the right rectus incision as compared with any other method of opening the abdomen. The direct incision, however, is more hemorrhagic, for with gentle manipulation and guarded retraction any material bleeding may be avoided in the indirect plan. Compared to the others it must be admitted that any form of incision in the right rectus area is more difficult to make and more troublesome to close. It takes time, patience and good assistance to get in by this route and an even more abundant supply of these elements to restore the divided parts. Moreover there is always tension, sometimes more and sometimes less, but always some, requiring rather tight suturing. The usual method of closure is by suture of the peritoneum with plain gut (often very difficult unless some of the muscle be included), forty-day chromic gut on the fascia and silkworm gut through and through down to the peritoneum or in the skin only. When deeply applied the silkworm gut is likely to puncture vessels, thus causing annoying hemorrhage beneath the aponeurosis. Hematomas are not infrequent. These can be avoided perhaps by many ligatures and compact stitching, both of which predispose to infection. In the very few cases nowadays of suppuration occurring in clean wounds, my experience and that of others known to me seems to show the largest number in low right rectus incisions. The factors mentioned would naturally favor infections. Again, if the right rectus incision is of any useful length, nerve fibers are inevitably severed, thereby impairing the muscle tone.

These objections are more than atoned for by the distinct advantage of the right longitudinal incision. It gives access to the appendical region, from the median aspect, allows wide inspection of the abdominal cavity, permits simultaneous operations upon other structures. Although patients frequently complain of pain in the incision for a longer time than after other types, yet for the most part the right rectus incision heals well and becomes firm.

3. The transverse incision is not so well known or widely used, but it is deserving of serious attention. Although popularized and modified by Davis (1906) and in many quarters known under his name, this incision appears to have been first suggested by Elliott (1896) to whom Davis gives credit. Elliott's plan was to divide the tissues from the outer border of the right rectus toward the anterior superior iliac spine and external oblique muscle down to the peritoneum, then to enlarge the incision, if necessary, by cutting along the semilunar line or into the rectus muscle. Davis opened the rectus sheath and retracted the muscle toward the left. According to Deaver, Chaput (1905) described a similar method.

It has come to light that in the same year a transverse incision for removal of the appendix was proposed by Rockey, who ever since has been the most consistent advocate of this type of approach. In more than one article he has impressed the value of the transverse incision, especially in the suppurative cases when drainage is needed and believes that, if he could further convince surgeons of the practical advantage of this method, the percentage of transverse incisions would be greatly increased. Rockey's plan is that the incision should be made through the skin and fascia directly across McBurney's point, so that its inner extremity is over the belly of the rectus muscle and its outer just above the anterior spine of the ileum. The only parts that are cut are the sheath of the rectus, the aponeurotic junction at its external edge and the aponeuroses of the oblique muscles, both of which have their fibers running practically in the same direction—directly transverse. In connection with a right-sided posture, transverse incision permits free drainage by gravity with the drain protruding from the outer end of the wound. Its closure is easily accomplished by separate suture of the peritoneum, the rectus sheath, the musculo-aponeurotic layers, and the skin union by this method generally is solid.

I can testify to the real worth of the transverse incision. After reading the paper by Davis in 1906 I employed this incision in a series of forty or more cases, as indicated, in order that I might become accustomed to it. I derived great satisfaction from the operations done through this incision and offer commendation for its facility of performance, its roominess for manipulation, and its firm healing. One of the patients refused to remain in bed the night following operation, walked continually around the room and into the corridor; but the resulting scar was strong and almost invisible after three months. In spite of all this, somehow I did not continue to employ the transverse incision, for what reason I know not. In a very few cases during these twenty years I have used it when suggested. I am sure that most surgeons rarely, if ever, perform the transverse incision. Possibly they regard it as unanatomical, or feel that it is unnatural to operate through such an abdominal opening, or consider it unnecessary to add another type of incision to those already in use. But this transverse type of incision should not be overlooked. It has possibilities and may be found to fit cases in which the other two incisions do not work favorably. The pelvic appendix is not suitable for the transverse incision, nor will it suffice when the appendix is situated high up under the liver.

Other Types of Incisions.—From time to time there have been proposed extra or supplementary incisions for special cases. These have had to do largely with meeting unusual conditions, as an abnormally placed appendix, a walled-off abscess in an uncommon situation, or the necessity of approaching the appendix through an incision for a different operation. Almost all the suggested incisions are modifications or varied applications of the three main forms just described.

Whitelocke proposed "a new route for appendectomy" through an incision one-half inch internal to, parallel with, and very near, the anterior superior spine of the ilium, extending equally above and below it. After going through skin and fascia, the muscles are divided in the direction of their fibers, retraction effected and the peritoneum divided anteriorly in uncomplicated cases; but when an abscess is present or suspected, the peritoneum is turned inward and incised posteriorly from the iliac fossa. Advantages claimed are that the small intestine is very rarely exposed in the wound and that drainage is away from the peritoneal cavity, not through or toward it.

A method similar to this was published in 1924 by Wood, who had been using the technic for five years. The external incision was placed in somewhat different fashion, but the peritoneal entrance was made in the same manner.

A lumbar incision to reach the appendix was practiced by Meucci when nephropoxy or plication of the cecum is to be performed, or when the appendix is judged to be retro- or para-cecal. He finds less percentage of postoperative hernia following this incision in the loin.

This is true, but that region in my opinion is not entirely immune against hernia.

An incision for retrocolic appendicectomy was described by Descomps. It was generally between 4 and 6 centimeters long and perpendicular to a line drawn from the anterior iliac spine to the umbilicus, about where its middle and external thirds join. The ascending colon is approached from within outward so as to reach its posterior aspect. Opening the peritoneum parallel with the colon down to the iliac fossa and turning back the colon, with the cecum and terminal ileum toward the median line brings the appendix readily into view.

A "*posterior subiliac incision* in certain types of appendicitis" was the contribution of Lecene. His incision, 8 to 10 centimeters in length, lay about 2 centimeters above the anterior superior spine, dividing the muscles in the direction of their fibers. By wide retraction there is brought to view what Lecene refers to as "the external peritoneal culdesac" formed by the transversalis fascia and the peritoneum. From this area drains pus, when opened in a case of appendical abscess. Security against hernia, efficient drainage and prevention of peritonitis are claimed for this method.

Willy Meyer has recommended an *additional posterior incision* for removal of the inflamed retrocecal appendix. Sometimes it is done as the original and only operation, but more frequently as a secondary incision when the appendix could not be visualized and comfortably removed by means of another method. This incision, like that of Whitelocke, Wood, and Descomps, passes very near the anterior iliac spine; separates the fibers, of the external oblique, but, different from the others, severs those of the internal oblique; and opens the peritoneum at the lower angle. By prolonging the incision the retrocecal appendix can be completely exposed in its entirety, no matter what may be its length or direction. If drainage is needed, it is instituted through the posterior incision, while the anterior incision (usually the McBurney type) is closed tightly. According to Meyer's personal records he first used the additional posterior incision for an adherent retrocecal appendix in 1896.

Comment.— Summing up, it is evident that the two chief incisions for operation on the appendix are the gridiron and the right rectus. Of these the one most commonly employed, as far as I can discover, is the gridiron or McBurney. Some form of muscle-splitting incision necessarily will always be popular, both for its opening and its closing qualities. The layers of such an incision incline to come back together after being severed; there is no tension. Many wounds of this sort would heal without sutures. I confess to a prejudice in favor of the McBurney incision; for its anatomical correctness, its ready and rapid execution, its perfect closure, its wide adaptability are not possessed by the other methods. In the majority of acute appendicitis cases, in the subacute types and in some of the chronic cases. in which other conditions have been positively eliminated, it is the incision of choice in our work. Even in the cases requiring extensive drainage it is indicated, along with stab openings below, near by or posteriorly and with loose closure of the incision itself.

But we find the right rectus incision necessary for intelligent operation in the vast majority of chronic appendicitis cases, in those complicated by lesions of the female generative organs, and in the pelvic appendix, suppurating or inflamed. No hesitation is felt in using the incision near or through the right rectus, whenever it seems called for. It is more difficult to make and to sew up, it takes time, and it seems anatomically more awkward. But in the main it gives satisfaction. Many surgeons employ it altogether and teach the method to their assistants and students as the one only to be used. Yet I have observed many of these pupils after establishing later their own surgical services adopt the gridiron incision as a routine. All of which would lead one to remark that the operator should take up the incisions which he can perform with the greatest ease and in which he may become adept, suiting each one to the particular case, willing to modify it as judgment demands.

The transverse incision appears to be useful in certain types of acute suppurative appendicitis, chiefly for its help in postural drainage. It does not offer many advantages over the McBurney incision and anatomically is more complex. For this reason and for others previously expressed, the transverse incision has not become a favorite.

The special incisions are all based upon the muscle-splitting principle. They are either modifications or extensions of the gridiron idea, placed at different points and changed to suit unusual conditions.

Locating the Appendix.—*Intraperitoneal Technic.*—After the abdomen is opened the next step depends upon the type of case. If the operation is done for chronic appendicitis and the incision will permit of it (as it should), exploration by hand, and as far as possible by the eye, should first be made of all accessible organs before disturbing the appendix. This is both psychologically and technically reassuring. It is better to find complicating pathology previous to the accusation of the appendix than after it. If the case be acute or subacute, an instant search for the appendix is to be made. Finding the cecum and sweeping the finger around it to locate the appendix gives a general impression of the field. Under no conditions must the appendix be jerked or pulled away from any situation until its pathological state is determined, for it may be on the eve of perforation or an existing hole already covered up may be exposed. In any case, acute or chronic, the surest way of locating the appendix is to stick to the cecum, following its anterior longitudinal band which leads to the base of the appendix. This, it should be recalled, is at the ileocecal junction—not at the lowest pouch of the cecum, not underneath its projecting portion, but just where the ileum joins the cecum. Delivery of the cecum into the incision, therefore, includes bringing up the ileum, and spreading it out, away from the cecum, a maneuver which facilitates the manipulation of the appendix. When the appendix is well in hand, a portion of the cecum can be rolled back into the abdomen and all but the terminal two inches of the ileum can be allowed to fall within the cavity. One can then proceed to remove the appendix according to whatever method commends itself.

Three methods of locating the appendix are mentioned by Ashhurst: (*a*) Two fingers of the left hand are inserted into the incision and carried along the anterior parietal peritoneum as far as possible, then brought back upward along the brim of the pelvis (noting the pulsations of the external iliac artery), until they engage in the ileocolic mesentery, where the appendix can be felt and then be brought up. (*b*) The fingers are passed upon the parietal peritoneum from the outer to the inner side of the wound across the iliac fossa, where they will be arrested by the cecum which is to be drawn into the wound and its longitudinal band traced downward to the appendix. (*c*) The abdominal contents, which means all the movable structures, are packed toward the patient's left, when the more or less fixed cecum remains immovable, is pulled into the incision, and the appendix delivered. Ashhurst refers to the last procedure as less brilliant, but the surest method of all.

Only in very exceptional cases should difficulty be encountered in locating the appendix. When there is a very short "nubbin" of an appendix, when it is small and enveloped in dense adhesions, when it is plastered flat against the cecal bands in front or behind and in the exceedingly rare instances when it is absent—these constitute good reasons for failure to find or to properly locate the appendix. But in ordinary cases the simple expedient of taking hold on the cecum, tracing its longitudinal band downward and securing the ileum will be successful. The spectacle, exhibited by some "occasional" operators, of fishing around in the peritoneal cavity for the appendix suggests the childhood game of "bobbing" for apples. Every time they haul up something it seems to be the wrong thing. There is no excuse for attempting to catch the appendix "on the fly." It should be located with its neighboring structures. It should be easy enough to recognize and distinguish the cecum on account of its more or less fixed relations and its surface markings.

A distinctive anatomical mark has been noted by Payne. In one thousand successive abdominal sections he observed that the vessels of the terminal ileum run longitudinally and not transversely, as in the other portions of the intestinal canal. He comments as follows:

"From the pylorus downward in the small bowel to a point approximately one and one-half inches from the ileocecal valve the visible vessels run at right angles to the long axes of the bowel, passing up from the mesentery on each side of the convex surface to meet over the point opposite the mesentery. In the last inch and one-half of the terminal ileum there are, however, one, two or three small straight vessels which come up from the anastomosis formed by the ileocolic and the right colic arteries, sending these branches upward from the ileocecal valve just under the peritoneum and parallel to the long axis of the bowel for a distance of one-half to one and one-half inches or thereabouts. These straight vessels . . . are definite end arteries and run immediately beneath the peritoneal coat of the bowel, whereas the other blood supply of the small bowel runs between the mucosa and the submucosa. Payne believes that "the greatest use for this definite anatomical point is probably to be found in locating the appendix, using the last inch and one-half of the terminal ileum as a more definite and more ready guide to the base of the appendix than other methods of location, such as following the longitudinal bands of the large bowel."

Peritoneal Protection.—In operating upon cases of suppurative appendicitis, either with walled-off abscess or with pus free in the peritoneal cavity, it becomes necessary at times to pack off the intestines away from the purulent area. Care should be taken lest the peritoneum be contaminated in the very effort to protect it. Working from a dirty toward a clean region, it is quite possible to push septic material into the uninfected area by the gauze pads intended to wall off the intestinal coils. This rather grave error is committed not infrequently. Guarding against this break in the technic, the placing of moist packs in uncontaminated areas enables one to work in the restricted field where infection is confined. Often, however, bulky pads hamper the necessary manipulations. Moreover, when free purulent fluid is present, it is impossible to pack off any considerable amount: there is scarcely any clean space. In such instances sponging away the pus, attention to the perforated appendix, and instituting drainage are the requisites.

The peritoneum can best be protected in these cases by gentle manipulations so that no abrasion or irritation occurs. Heavy and forcible retraction should be avoided. In many cases the cecum may be drawn up into the incision, acting as a plug, with the infected appendix outside, so that no retractor is needed. Instead of gauze sponges in the abdominal cavity, some surgeons use an aspirator for the continuous removal of pus and blood during the operation.

Management of the Appendix Stump.—From the very beginning of the surgical treatment of appendicitis the disposition of the appendix stump has been the subject of consideration. It will be recalled that not until the late eighties was there a definite program of invading the abdominal cavity and removing the appendix. Some operators even then contented themselves by suturing perforations in the appendical wall and replacing it within the cavity. Others ligated the appendix near the cecum, cut away the longer distal portion, and released the short stump without any attempt at disinfection of its mucous membrane. A few undesirable results came from this procedure. Later on sterilization of the stump by cautery or chemicals was practiced with success.

Apparently this method was regarded as crude or unsatisfactory, for the next steps were in the way of refinement, attempts to cover the stump with peritoneum. Fowler used a "cuff" method, sometime widely popular: temporary ligation of the appendix at the base, turning down a peritoneal flap on the stump, ligating inside this flap and releasing the former ligature, suturing the peritoneum over the small stump after pushing it into the bowel. The second edition of Fowler's book (1902) contains no reference to this method, but mentions simple ligation and cautery and favors another and later technic next to be described. Following this came the introduction of the purse-string suture by Dawbarn, who inverted the unligated stump into the cecum. For a period of years this was a generally accepted method; but gradually there appeared reported cases of postoperative hemorrhage into the bowel, and practically all surgeons went back to ligation of the stump, and then either dropping it back or burying it under peritoneal covering. Wyeth, an elder colleague of Dawbarn, led the crusade against nonligation of the appendix stump and in favor of ligating, disinfecting, and dropping which was the earlier plan.

A few more refinements were proposed only to pass after a while into the discard. One of these was the method of Edebohls—the inversion of the unopened appendix into the cecum—obviously of restricted application and difficult to accomplish, besides leaving to question what might become of the appendix inside the bowel. The plan was deservedly short lived. For a time Deaver cut away the appendix flush with the cecum and closed the opening with mattress-sutures, Lembert style, as in any other intestinal opening. Not in several years has this surgeon employed this method. It is risky; any break in technic or mechanical mistake may result in perforation and peritonitis. The late Joseph Price was wont to use this technic, saying as he did so that those who left a stump as much as one-eighth the length of the appendix did only "seven-eighths of an operation." There are occasions when complete amputation of the appendix and closure by suture of the cecal walls must needs be done, when the appendix has sloughed at the base, when its walls and those of the cecum are so thick as to preclude the cuff or inversion methods and in the presence of growths or extensive involvement of the bowel, as in carcinoma, tuberculosis or actinomycosis, along with a diseased appendix. I have practiced this 100 per cent removal of the appendix in these circumstances and, indeed, in the simpler, uncomplicated cases with a certain degree of satisfaction; but it is neither to be recommended as a routine procedure nor to be attempted by the average operator.

Many other variations have been proposed and performed. They are all modifications of plans previously suggested, changed in some manner to suit the individual taste and judgment. Combinations of methods are used in the majority of instances. Articles galore have been presented and technical details innumerable have been described upon this particular subject, disposal of the stump of the appendix. An American surgeon, now retired, read no less than seven consecutive papers with such a title. Some observers seemed to feel that just a slight alteration here or there in the usual technic conferred upon them the privilege of discovering a "method."

It is interesting to note that in 1905 Kelly stated that "in dealing with the stump of the appendix" two things should be avoided: (*a*) "simple ligation and amputation, leaving the mucous membrane exposed, whether sterilized or not" and (*b*) "ligating, amputating and burying the little stump by means of sero-serous sutures." And yet, it is precisely these two plans that are most widely employed to-day.

Ligation.—In this method the appendix is crushed by forceps very close to its base; the forceps is then removed and a ligature of catgut, silk or linen applied in the groove made by the forceps, while another pair is placed above. With a sharp knife the appendix is amputated between them and to the mucous membrane of the stump is applied carbolic acid (followed by alcohol), tincture of iodin, or the actual cautery, as preference indicates. A second ligature may be tied below in any case. The cecum with the appendix stump is then returned to the abdominal cavity.

Burying.—Whether the stump is to be turned flat and sewed over with peritoneum or whether it is pushed deeper into the cecum, in any event, the stump must receive some protective treatment. First a purse-string suture of linen, silk or chromic catgut in an intestinal needle is introduced into the cecal wall about one-half inch from the base of the appendix. A ligature is then applied as before in a crushed groove, the appendix cut away, the same disinfection carried out, and the purse-string tightened while the stump is tucked in. An extra suture through the peritoneum over the buried stump is reassuring.

There are a few operators who still perform *inversion* of the stump, according to Dawbarn's technic and this may be included as a third method. Its employment, however, is not nearly so frequent in the past few years. Maloney is authority for the statement that up to 1925 Ochsner was the only one among the leading surgeons still using the true inversion method. Too many hemorrhages resulted from failure to include the artery of the appendix. Those surgeons who had had a bleeding case abandoned the method and many others never began its use. Ways of catching the artery by going under it or looping back over it were suggested and in the main these manipulations were successful, but the exceptional case continued to produce annoyance. It is safe to say that the vast majority of surgeons everywhere, no matter what may be their plan of handling the appendical stump, first ligate it. Inversion then is hardly the term, for a tied stump cannot really be inverted. That implies that it is turned inside out and in such circumstances the ligature must give way.

Invagination, or ensheathing one part within another, is compatible with a ligated stump and this is the process which takes place when the appendical remains are tucked in deeply toward the cecal lumen. As a matter of fact, burial of the stump under the serosa, or its invagination deeper into the wall, are reasonably safe, provided sterilization of the mucosa is complete. Cutting out the mucous membrane of the stump with curved scissors previous to or instead of the application of disinfectants is effective.

Defenders of ligating, sterilizing and dropping the stump are prepared to show the dangers of any method of burying, invaginating or inverting it. Condemning equally the open idea, Kelly also objects to the burying procedure because it "has in more than one instance been the source of serious postoperative sequelæ." J. Shelton Horsley called attention to the inclusion of infective material in the wall of the cecum, spoke of a "diverticulum that occasionally forms after burying the stump" and of "a stasis at the base of the appendix where a purse-string suture has been used."

Maloney, who regards the ligation and drop method as the ideal procedure, denounces any plan of burying the stump, because in comparison it requires more time, is not so universally applicable, produces more trauma, leads to a greater number of fecal fistulae, is usually unphysiological, affords more danger of hemorrhage from the stump, originates inflammatory (foreign body) tumors of the cecal wall. On the other hand Maloney has found the ligation and drop method in 3,500 cases free from all disadvantages attributed to the other plan and in addition claims lessened postoperative gas pains and ileus, and absolute lack of adhesions.

Among 259 operations for acute appendicitis operated upon by Truesdell three patients bled into the bowel to an alarming degree but recovered without interference. In each case the stump of the appendix had been ligated only and the incision drained. Explanation is difficult. Perhaps the cecal walls were involved in the infection and the mucous membrane was hemorrhagic.

Seelig continues to reiterate his objections to the buried appendix stump, in that hemorrhage is likely to follow, sloughing after infection or penetration of the bowel wall is apt to ensue and even fatal peritonitis from a "blow out" may occur, as in a case he quotes from Rydygier. Seelig's tribute to simple ligation is based upon his experience, first outlined in 1904, showing that "a properly cauterized stump is not infective": bacteriological studies have always proved them sterile; later inspection of these stumps presented smooth sites, free from adhesions; simple ligation is secure and the stump is "morphologically ideal," in spite of the fact that mucosa is brought into contact with mucosa.

Contrary evidence is furnished by Hugier and Lanos. They report two cases of intestinal obstruction following appendicectomy without burial of the stump. In the first case of subacute type, occlusion occurred twelve days after operation with a previously normal convalescence and was relieved by enterostomy; in the second, a chronic appendicitis, symptoms of ileus began nine days after operation also without former indication. Although many surgeons have left off invagination and covering of the stump, these observers are of the opinion that, in their two cases herewith described, failure to bury the stump bore a causal relation to the infection which produced the obstruction.

Roeder's intraperitoneal observations in 105 patients who had been previously submitted to appendicectomy demonstrated crippling adhesions in 85 per cent, causing constipation anew (35 per cent) and intestinal obstruction (3 per cent). The two factors most often overlooked in the etiology of such adhesions are the purse-string suture and the uncared-for stump of the mesoappendix. Since the former is placed wholly in the cecum, it must be remembered that this portion of the intestine possesses the thinnest walls and the highest bacterial content of all. It is believed that penetration of the needle into the mucous membrane of the cecum frequently occurs when the circular suture is being laid. The mucosa of the stump is best sterilized by phenol, which seeps into the deepest portions, not touched, as a rule, by the cautery. The crushing forceps represents a source of infection, by forcing bacteria through the walls of the appendix and thus contaminating the ligature. In five out of twenty instances cultures were positive for pyogenic bacteria, when the appendix was amputated by the cautery; in no case out of twenty, when carbolic acid was applied to the mucous membrane of the stump, was a culture obtained. Roeder believes that purse-string appendicectomy must be looked upon as a potentially contaminated step, to be safeguarded as far as possible. He says: "The inverting suture is ideal if penetration of the cecal mucosa can be prevented. When this suture becomes most difficult to apply, it should always be dispensed with, providing the stump of the appendix can be sterilized."

Comments.—After all is said and done it seems to make little difference how the appendical stump is disposed of, provided the technic is carefully carried out. In all parts of the world every day thousands of appendicectomies are performed by hundreds of surgeons. No two of these surgeons employ precisely the same method—and yet all obtain just about the same results as far as treatment of the stump is concerned. Occasional accidents are heard of after any plan. Actual inversion of the unligated stump has been given up, chiefly on account of the danger of hemorrhage. Criticisms of the ligation and burial of the stump were voiced in the preceding paragraphs. Simple ligation and dropping of the stump after sterilization likewise has furnished mishaps. Some years ago this method was used in forty-seven consecutive clean cases in our service. The next stump treated in the same manner burst into the peritoneal cavity on the second day, and but for the timely plunging of forceps through the incision and the insertion of a drain, a fatal disaster probably would have occurred. Naturally this plan was discontinued until long afterward, when we found that it had great merit and could be used successfully. Now it is performed with confidence when occasion presents and judgment indicates.

Every surgeon thinks that his own method is the best, and probably so it is—for him. Without question each operator comes to develop a technic that suits him and that he can carry out with comfort and success. He should stick to that method. This applies particularly to the simple chronic cases. In the acute types and all complicated cases the technic will necessarily be changed to fit the conditions. When the cecum cannot be lifted and the appendix cannot be delivered, ligating and dropping the stump can be done; if the base of the appendix is widely indurated and a purse-string suture is difficult or impossible to insert, the old fashioned "cuff" method is available; in cases where the appendix has sloughed and there is no stump, Lembert stitches in the cecum to cover the orifice are in order. In all other instances, the uninfected and more or less normally related appendices, it seems proper to tie, sterilize and invaginate the stump, giving due heed to avoid any sort of contamination. This is not to desert the easy plan of ligating, disinfecting, and dropping the stump. It is used, but somehow, as Seelig remarks, it "has never commanded general approbation," appearing to lack "the elements of refinement that appeal so strongly to the better surgical instincts."

Personal Method.—Under ordinary conditions the technic employed in our clinics is somewhat as follows: After the abdomen is opened by whatever incision seems suitable, a retractor is inserted to the inner side. This is the only retractor employed except in very unusual cases. The cecum is delivered through the incision, pulling the appendix with it. The assistant then grasps the cecum with a moist gauze sponge in his right hand (Fig. 41) and holds it steady in this position during the greater part of the operation. The appendix, now well up in view, unless bound down by adhesions which must first be loosened up, is held by a clamp upon the meso-appendix. In no case is the appendix itself caught by forceps. The retractor may now be dispensed with. As many clamps as necessary are placed upon the mesenteriolum and the appendix separated down to its base by cutting between it and the clamps.

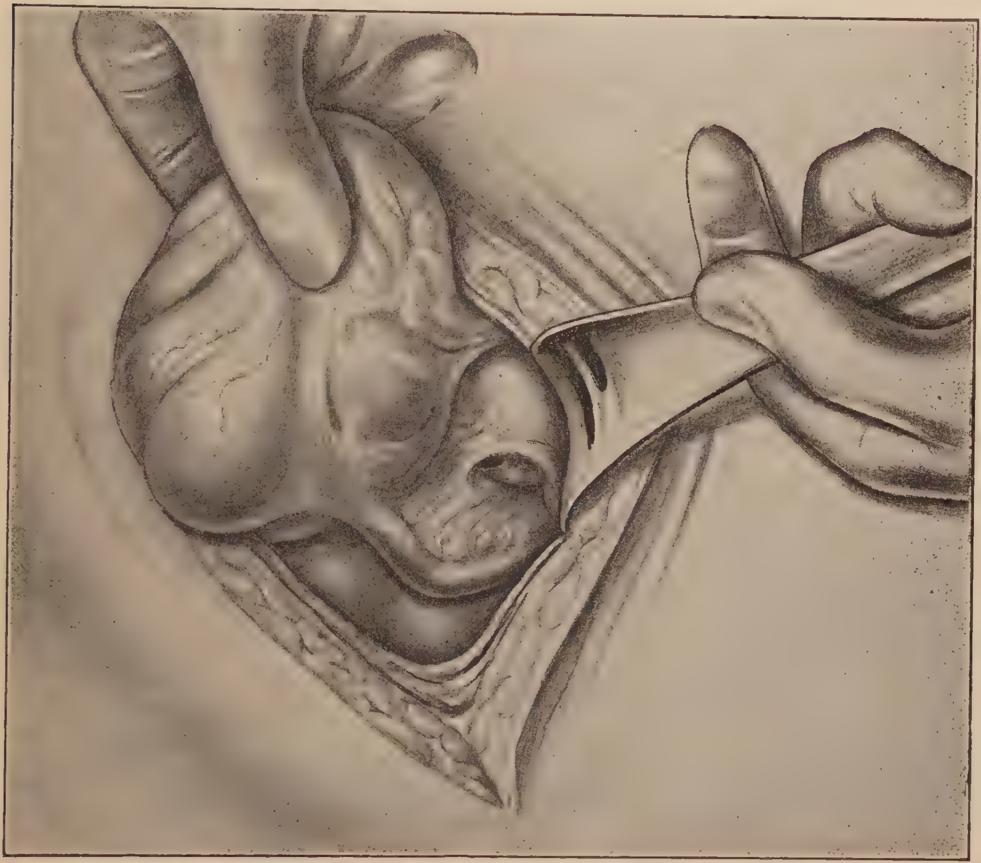

FIG. 41.—THE CECUM IS DELIVERED AND GRASPED BY THE ASSISTANT.
A sponge should be shown in the assistant's right hand.

Crushing forceps are now rather lightly applied to the appendix as low down upon the cecum as possible; a plain catgut ligature is tied in the groove made by the crusher and cut short. A purse-string suture of linen or chromic catgut is carried around the base of the appendix, beginning at the border of its mesentery, including both its leaves, and taking only four or five bites through serosa into submucosa. It is advisable to place the circular suture far enough away from the appendical base to provide for its burial. The purse-string is left loose, its ends being covered with a sponge or caught with forceps. Next a clamp is placed just distal to the ligature and the appendix is amputated with a sharp scalpel (Fig. 42) or by the cautery knife (Fig. 43) between forceps and ligature, leaving just enough stump to hold the ligature. If the scalpel be used, the mucous membrane is hollowed out of the stump by one cut of scissors curved on the flat (Fig. 44) or swabbed with carbolic acid followed by alcohol, or both may be done. In well over one thousand cases I have cut out the mucosa without any disinfection whatever and without the slightest untoward effect so far as we were able to observe. When the cautery is employed for removing the appendix, it is also depended on to sterilize the stump by direct application while the ligature and the circular suture are both held taut. Now and then tincture of iodin is smeared on the stump instead of phenol. The purse-string is now tied as the assistant pushes in the stump with a pair of artery forceps (Fig. 45), a grooved director, an applicator, or a specially made tucker. The last is most satisfactory. Two knots on the purse-string are sufficient. Its long end is then held and a

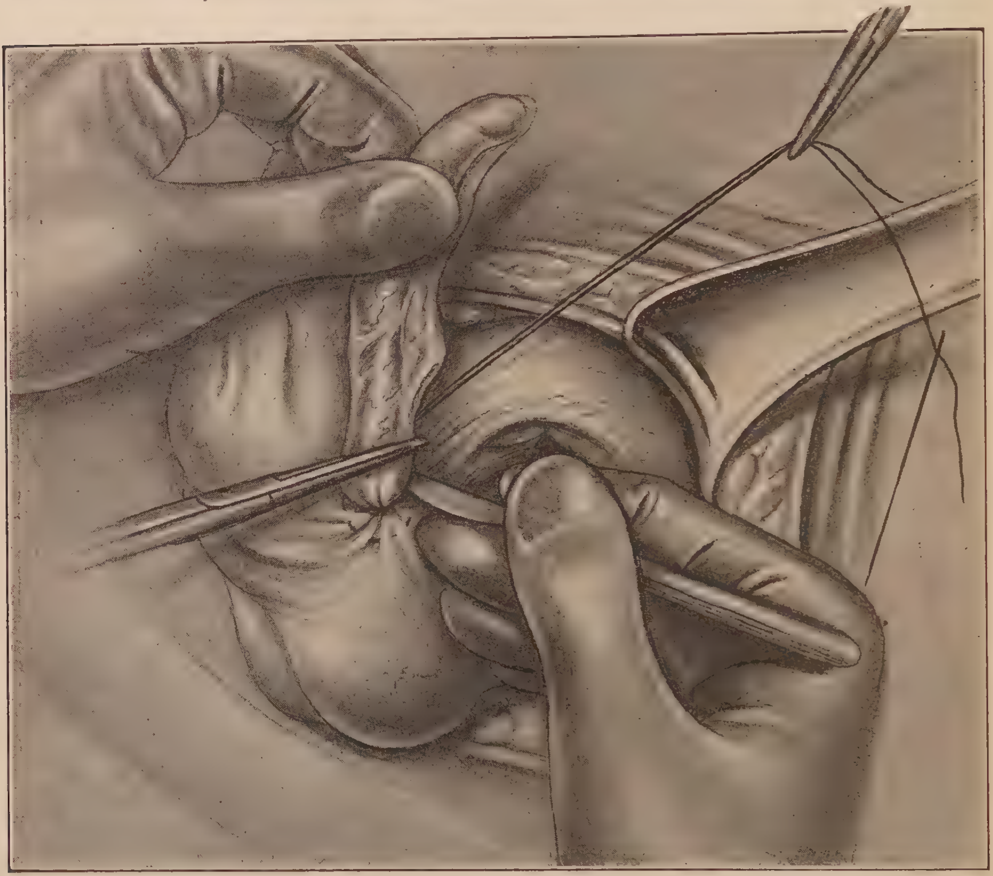

Fig. 42.—The Appendix Is Amputated with a Sharp Scalpel.

double cross-stitch is inserted with the same needle in the peritoneal coat of the cecum and tied twice, securely covering the stump (Fig. 46). Ligatures are now applied to the meso-appendix underneath the clamps which are released. Instead of clamping the mesentery of the appendix, it may be transfixed at its basal attachment and tied *en masse*. This is especially desirable when it is short and thin. In either event any glaring raw surfaces may be covered by suture.

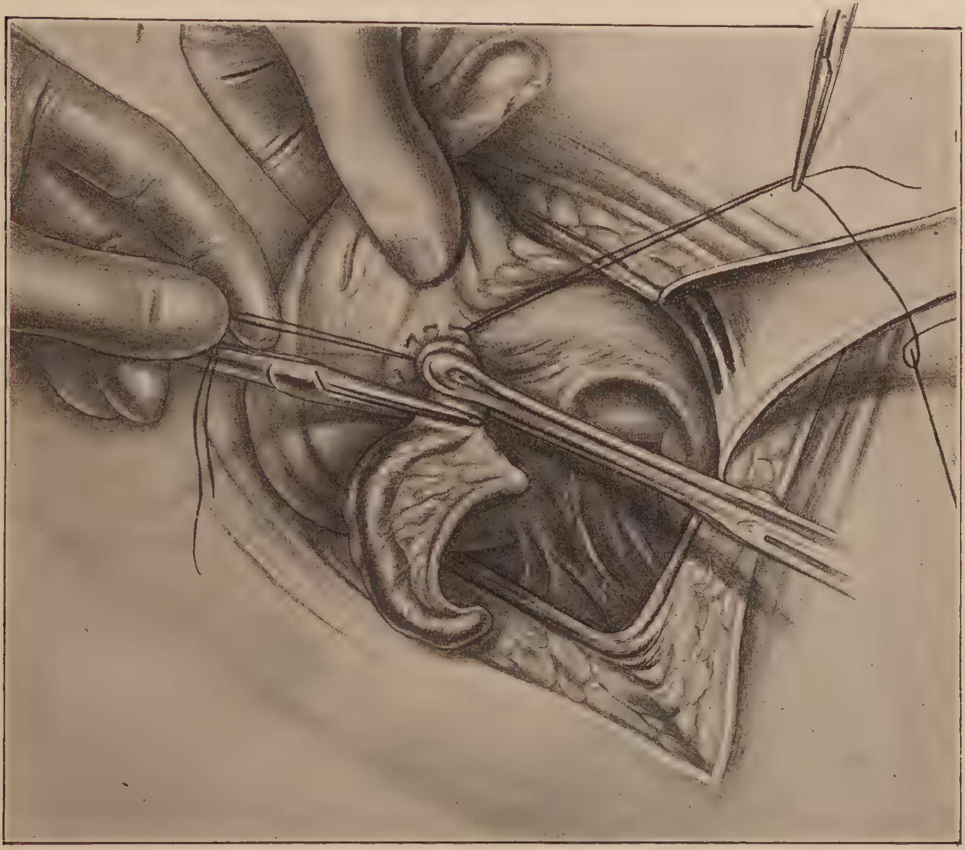

Fig. 43.—The Appendix May Be Amputated with the Cautery Knife.

The incision through the abdominal wall is restored in layers using plain catgut on the peritoneum, chromic catgut on muscles and fasciæ and silkworm gut, or other nonabsorbable material, for through-and-through suturing or in the skin alone.

This description relates to an uncomplicated case in which no difficulties are encountered, no particular dangers feared and no drainage needed. Attention may be called to certain features which make for safety, simplicity and speed. The use of only one retractor particularly in the McBurney incision prevents evisceration; allows the manipulation to be done outside the peritoneal cavity when the cecum is drawn up, and this effectually plugs the opening, doing away with further need for retraction until the wound edge is lifted for replacement of the cecum. The simple plan of handling the stump presupposes extreme care without being meticulous, admits unavoidable exposure without contact, cuts down needless details and anxiously thought-out "steps." Omitting nonessential movements lowers the percentage of technical "breaks." The saving of time is a desirable element if it violates no principle. Especially is this true when the appendix is to be removed in the course of other operations of greater magnitude. The easier the method, consistent with security, the sounder its qualifications. There are numerous extra features that might be added to every appendicectomy which apparently would add to the cosmetics or the refinement of the opera-

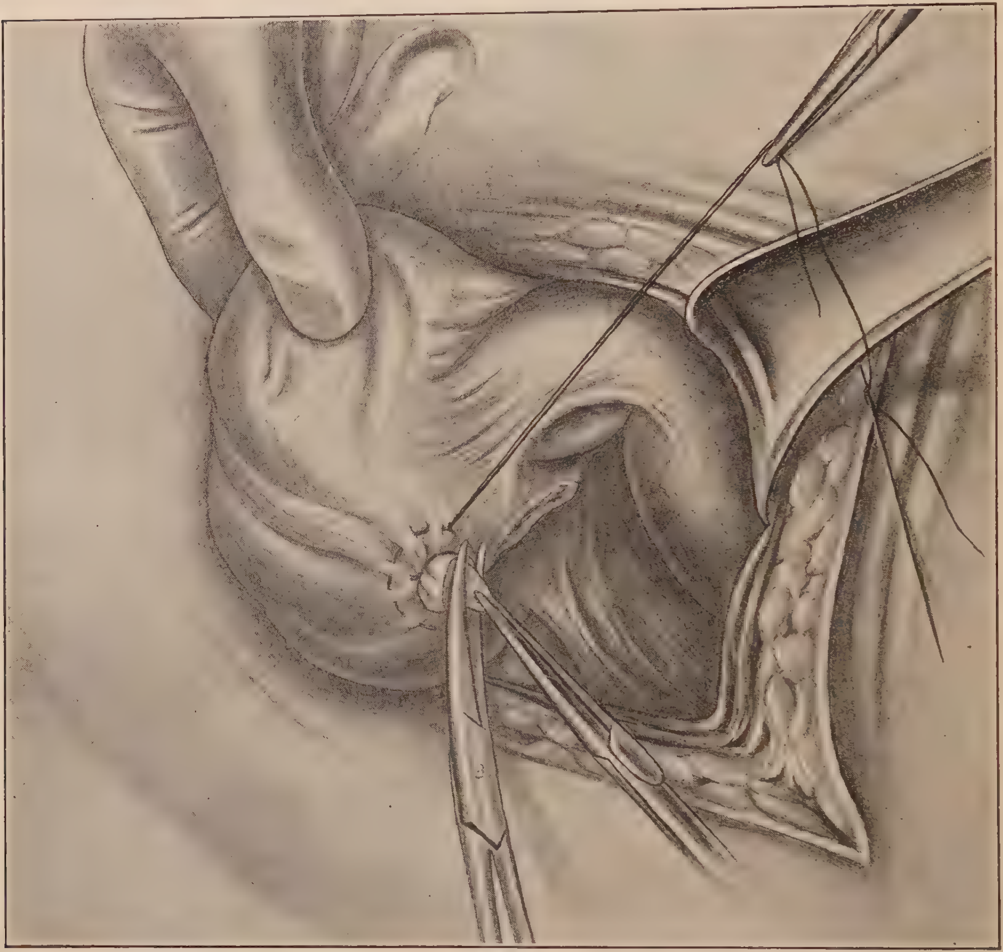

FIG. 44.—THE MUCOUS MEMBRANE IS HOLLOWED OUT OF THE STUMP WITH ONE CUT OF SCISSORS. It is rarely necessary to pull out the membrane by forceps.

tion, but which on analysis are really casual or discretional. In essentials, compliance; in nonessentials, avoidance.

Other Methods.—Altogether the procedure proposed here has yielded uniformly favorable results. But it has been and will be forsaken when altered conditions present themselves and when more serviceable means are brought forward. We do not hesitate a moment to adopt any plan in any case that will most surely meet the indications either in locating the cecum, delivering the appendix, or treating the stump.

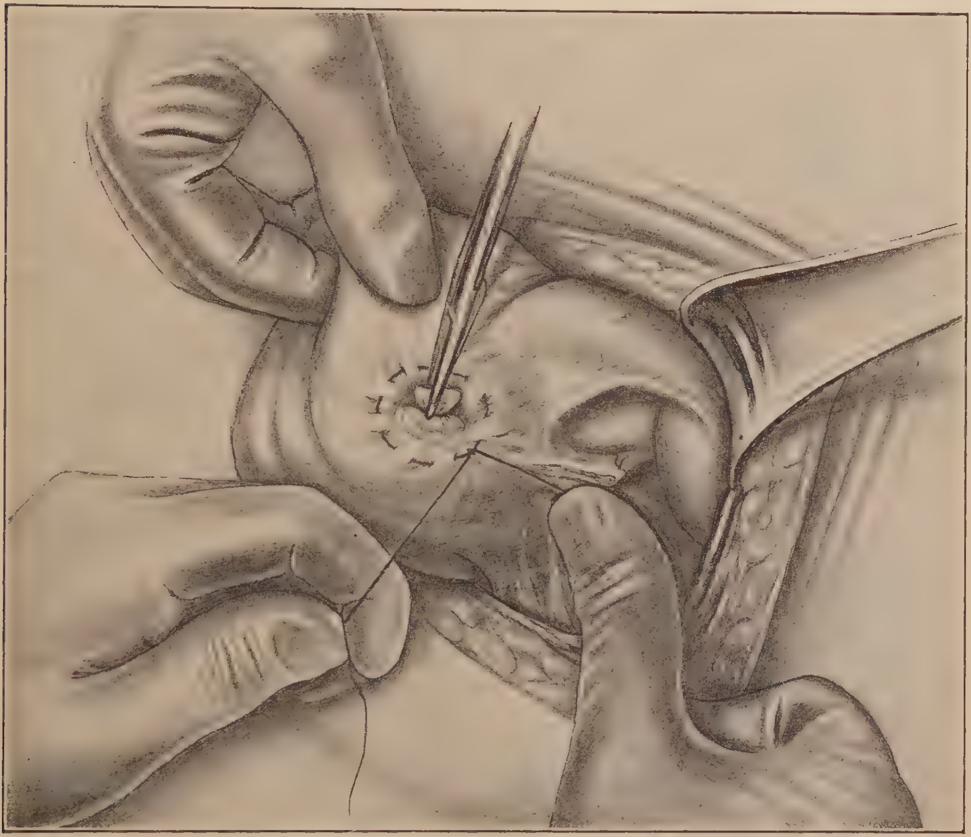

FIG. 45.—THE PURSE-STRING IS TIED AS THE ASSISTANT PUSHES IN THE STUMP.

Multiplicity of methods is the vogue in respect to all of these questions. Individual surgeons are using their own ideas and individual cases demand different technic at the hands of all surgeons. Modes of locating the cecum have already been reviewed. In delivering the appendix it has been my invariable rule not to clamp it with forceps. It is apt to break, even when in the best of condition, and squirt its contents into the cavity or upon the wound edges. So much greater is the danger of this catastrophe when the appendical lumen is distended with pus or when its wall is on the verge of rupture. In addition, injury of the appendical coats by the forceps beclouds the postoperative examination, in that the contusion may be mistaken for a preoperative lesion. It is my general custom to wrap the appendix completely in a piece of moist gauze when handling it, either for the purpose of extracting it by dissection or of holding it during disposal of the stump. In such circumstances leakage from the appendix would not contaminate adjacent parts. A very large number of operators, however, place a clamp on

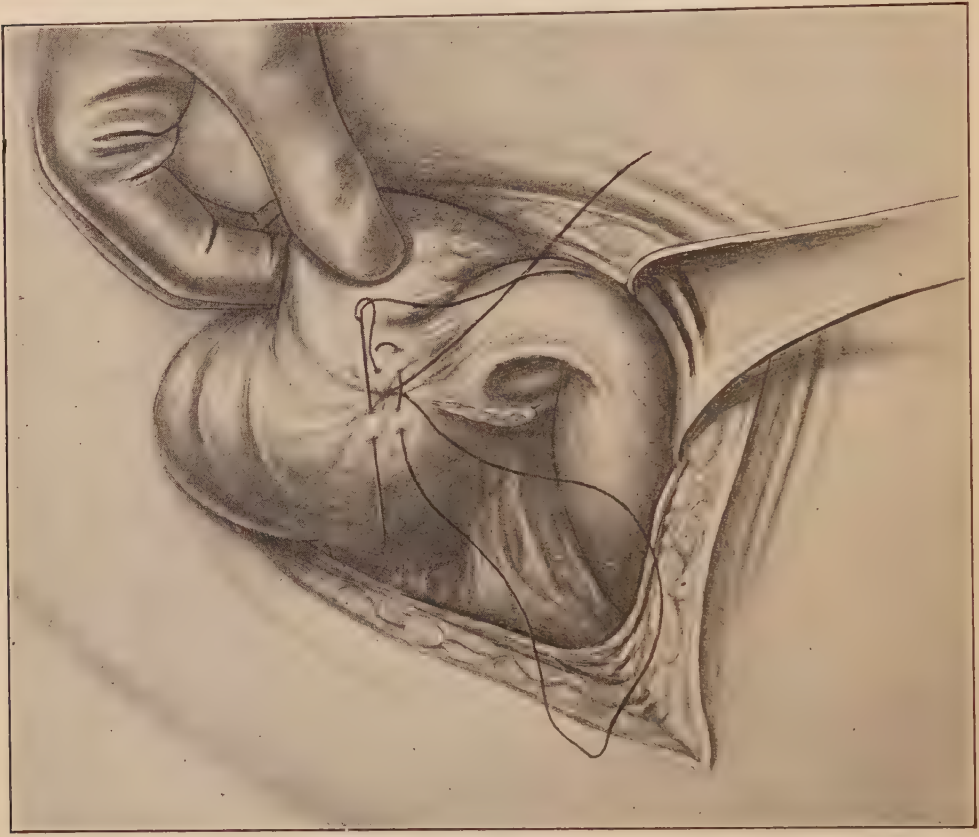

FIG. 46.—DOUBLE CROSS-STITCH THROUGH SEROUS COAT OVER STUMP.

the tip or the middle of the appendix as soon as it is in sight, employing the instrument to bring up and support the appendix during the steps of its removal. There is no condemnation for those who follow this technic; it seems to succeed. It does appear that a forceps on the free edge of the mesenteriolum would be just as useful and much more safe.

A helpful suggestion, especially for acute cases, has been made by Robins. He catches the appendix across its base with a pair of stout forceps and then describes a quarter of a circle with the handle thereby accomplishing its easy delivery from the wound. These advantages are claimed: There is done

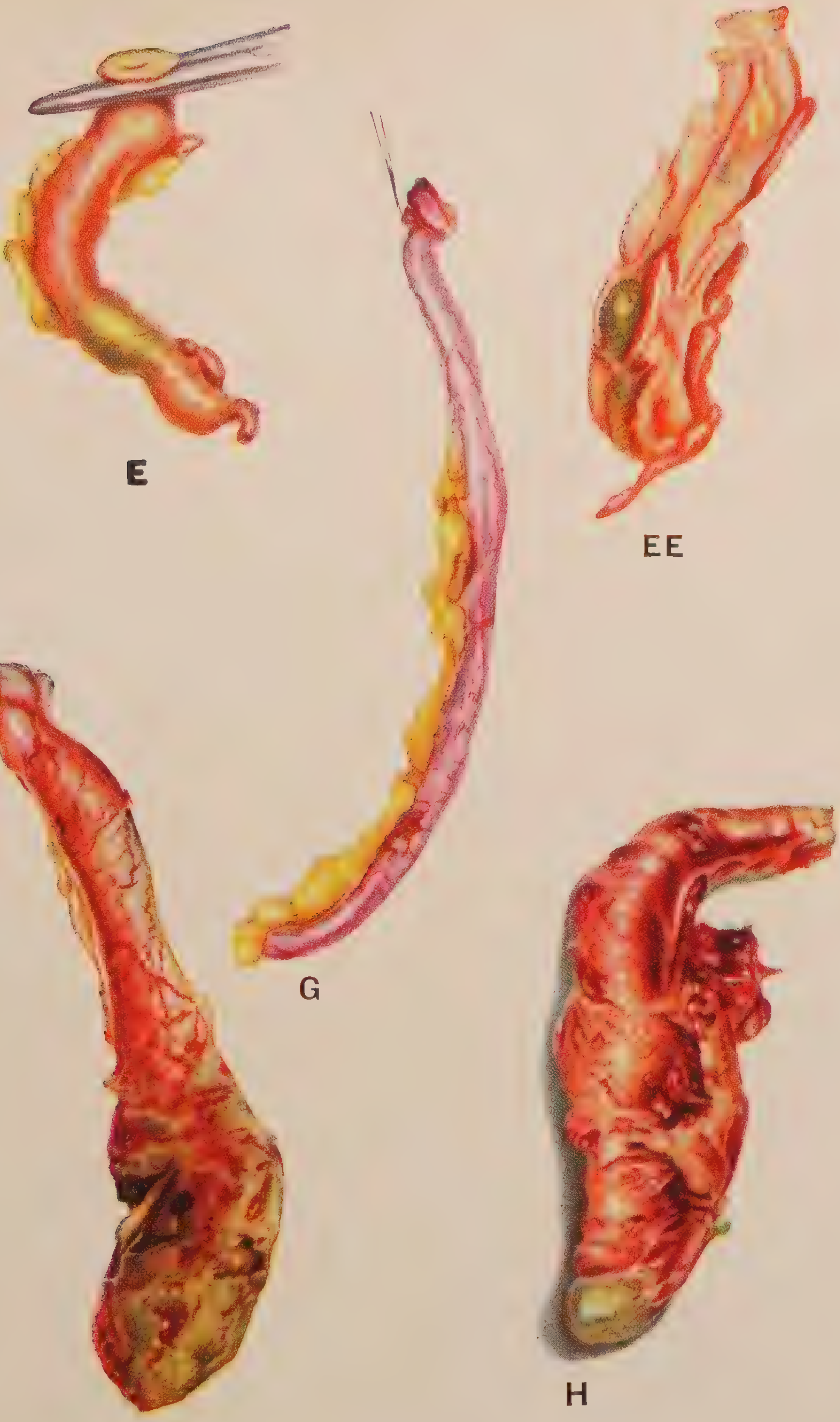

PLATE II

Descriptive Types of Appendical Pathology Representing Practical Features in Four Forms. (Drawn from actual specimens)

E. Unruptured appendix beginning gangrene.
EE. Appendix incised showing fecalith.
F. Acute gangrenous perforated appendix with fecalith protruding.
G. A long retrocecal appendix removed by retrograde method.
H. An appendix with gangrene of the tip removed by retrograde method.

away with the search for the appendix by the fingers, which occasionally squeeze it so as to produce a rupture; the base of the appendix, being most often uninvolved in the inflammatory process, furnishes a firm hold for the forceps with no fear of breaking; the clamp stops further absorption along that route; the operative time is shortened, trauma lessened, disturbance of other viscera unnecessary.

This technic is allied with that used in *retrograde removal of the appendix,* which has been practiced by many surgeons over a number of years. It serves a very definite purpose when direct traction on the appendix or delivery from the tip upward looms up as dangerous or difficult. In removing the appendix backward two pairs of forceps are placed—one immediately at the base and another above it with just enough space between for a knife blade. After cutting through, both ends, each engaged in forceps, are touched with phenol and alcohol. A ligature is then placed close to the cecum, further disinfection done and the stump dropped or buried, as preferred. Clamps are applied to the meso-appendix from above downward and the appendix gradually cut away, while it is being drawn upward by the forceps first in place. There are exigencies when this procedure is of great help. In chronic types with a long appendix bound down postcecal or retroperitoneal and in acute cases with a gangrene of the tip or an impending rupture, it is an invaluable method, preventing infection of clean areas, permitting amputation of the appendix *in situ* without tearing adhesions apart and exposing raw areas (Figs. G and H, Plate II). Eliason thus expresses himself: "This procedure (retrograde removal) is one we often use in subacute or chronic cases where the appendix is much swollen, indurated and bound to surrounding structures low down in the pelvis or behind the ileum without abscess formation. By this retrograde subperitoneal removal there is practically no danger of injury to other structures and there is decidedly less hemorrhage."

A unique variation in technic has been practiced by Reese (personal communication). After ligating the appendix at its base, a hypodermic syringe filled with alcohol is injected into the lumen until it is distended. The needle is entered just distal to the ligature. A clamp is then placed near the tied base and, as the appendix is severed between the clamp and the ligature, the alcohol flows out, affording protection against soiling.

DRAINAGE

To drain or not to drain—that is the question. It is an ever-recurring question. It will not down. The personal equation of the surgeon, his previous training, his contemporaneous experience have much to do with the decision. Some operators are prone to drain upon the smallest pretext and, when the patient recovers, credit is given to drainage. Others are slow to drain, except for positive indications and, should a fatal issue ensue, blame would fall upon the failure to drain. In each instance, habit or custom would be the guide, not knowledge or reason.

When to Drain.—It is much more difficult to determine *when to drain* than to learn *how to drain.* There are, to be sure, definite cases of appendicitis in which drainage is obviously and necessarily called for: a walled-off abscess, with or without removal of the appendix; perforation or gangrene of the appendix, with the presence of infective material in large amount, unrestricted and absorbing; peritonitis, intensive in its local manifestation or markedly diffuse. An equally important type of cases exists in which drainage is not demanded, certainly as a rule, leaving out the chronic cases and the perfectly clear acute cases: When there is present a gangrenous but unperforated appendix, wrapped up in omentum; a weeping but intact appendix protected by exudate; clear or nonodorous murky serum in the peritoneal cavity without rupture of the appendix. And yet there are those who insert a drain whenever any of these latter conditions are encountered, because they believe it may do no harm and might somehow do good. The possibility of intestinal obstruction from a drain must not be overlooked. Nor should the economic feature be neglected, for drainage weakens the abdominal wall and prolongs the disability.

For many years I have been interested in the question of drainage, chiefly from the side of economy. I have come to believe that the old motto of Tait, "when in doubt, drain," could be reversed and that it were better stated: "When in doubt, don't drain." There is never any doubt concerning the cases that ought to be drained—the localized abscess or the abdomen full of purulent material. The doubtful cases are those that need no drainage, as a rule; otherwise we would not be in doubt, but would decide frankly and freely to drain. Judgment and experience are required to settle these matters. Very likely more cases are drained that could do without than the reverse. "Doubt spells ignorance and complacently to submit one's actions to the ruling of such a motto is to spend a life of surgical stagnation" (Brockman).

There have been three steps in our conceptions of surgery. First we operated to save life, desperate surgery; then we operated to save health, preventive surgery; now we operate to save time, economic surgery. The greatest loss of time from abdominal operations occurs in cases that are drained, so that any method which reduces the confinement period to a minimum is desirable. When drainage is needed it becomes a matter of great economic value to use stab wounds outside of the incision rather than to place a drain through it. When this is done, in eight out of every ten cases the wound is kept intact and heals perfectly, while drainage is efficient and safe.

In some of the types referred to as doubtful in which the abdomen is closed, the wound suppurates, though the abdominal cavity remains free from infection. It is well known that the resisting power of the tissues in the abdominal wall is not so strong as that of the peritoneum. One is not surprised, therefore, when a leaky appendix is smeared over the open wound or a tight appendix is ruptured in lifting it out, to observe a swollen and tender area near the incision four or five days later. As a rule, the focus of this infection is under the aponeurosis and within the fibers of the internal oblique muscle. If the incision is closed loosely suppuration is not so apt to result.

In 1920, I proposed a plan for saving these suppurating incisions. It was described as follows: "Supposing that the wound has suppurated we will be apprised of its occurrence by continued pain near the incision, a possible rise of temperature, and an edematous, bulging area to one side of the incision.

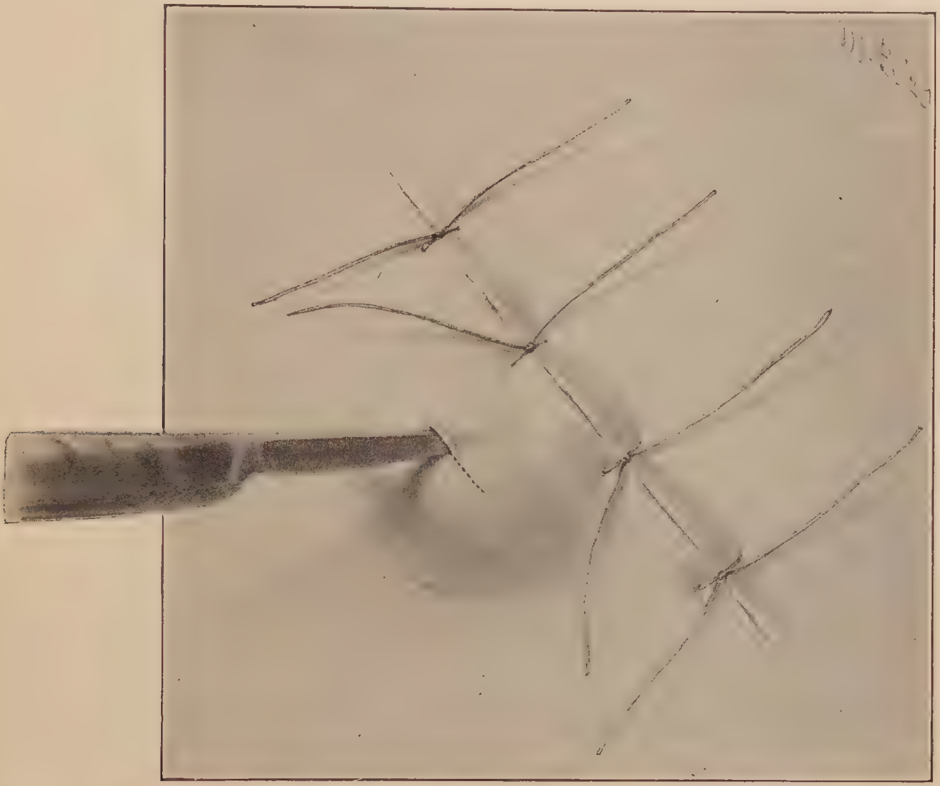

Fig. 47.—Edematous, Bulging Area to Outer Side of McBurney Incision. Bistoury Being Plunged In.

In the McBurney incision this swollen area usually is seen to the outer side of the wound (Fig. 47). As soon as the condition is recognized a small spot of skin at the most prominent part is injected with a local anesthetic, and a bistoury plunged deeply downward and inward. Through this small stab the pus is evacuated (Fig. 48), aided by pressure. . . . When the cavity is emptied a quantity (equal in amount to the pus removed) of a 10 per cent melted iodoform-vaselin ointment is introduced by means of a glass syringe (Fig. 49). This distends the cavity, fills the interstices, and solidifies on cooling (Fig. 50). A cold wet compress is immediately applied over the whole area and an ordinary dressing over this. As a rule, the wound is not disturbed for four days, when, on removing the dressing, the incision and the suppurating area will be found clean and intact. Slight pressure will cause any excess of ointment to exude and another cold compress may be put on. If before the fourth day a discharge be noted through or around the dressing, the wound again may be emptied by pressure and a second injection of the ointment made. following the same plan in the after treatment as outlined

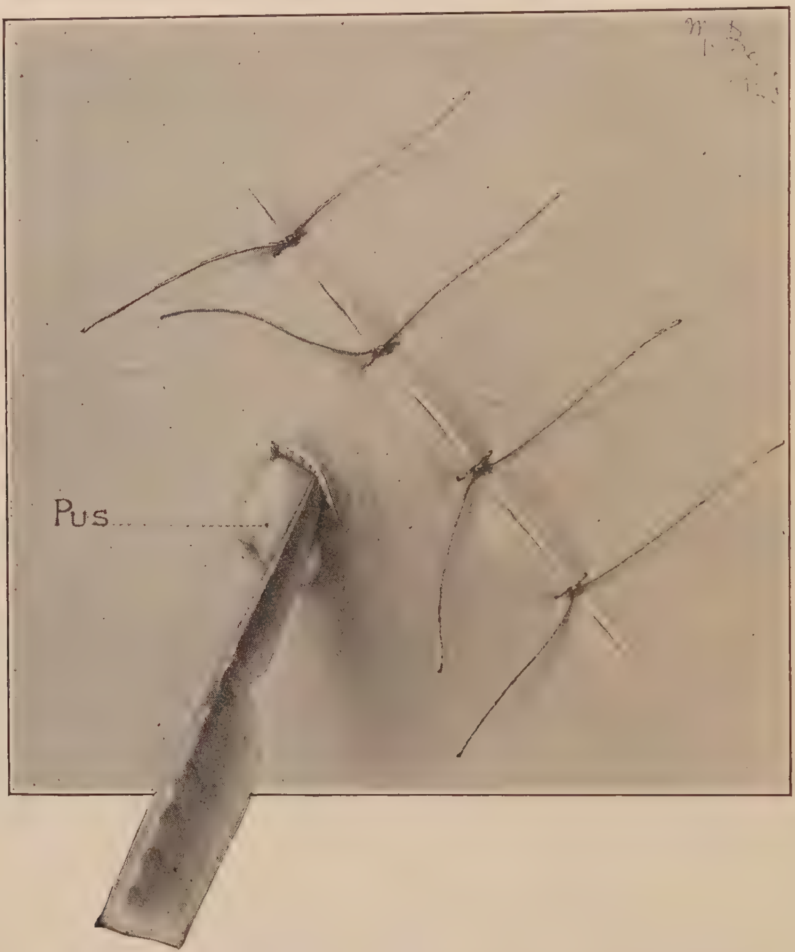

FIG. 48.—EVACUATION OF PUS THROUGH SMALL STAB INCISION.

above. The only advantage of the iodoform is its odor, which counteracts that of the colon bacillus in the pus. Before introducing the ointment the wound cavity may be washed out with Dakin's solution or a weak dilution of hydrogen dioxid; we have not found this essential."

It should not be inferred from the position here taken upon the question of drainage that one is to acquire a reckless mood when confronted with the alternative of inserting or omitting a drain. Such a momentous matter is not to be decided offhand, by rule of thumb, but carefully and conscientiously by each operator in each case according to the lights before him. It is not every one who can choose correctly in each case. The inexperienced surgeon had better overdo than underdo drainage, with the understanding that complications may arise and convalescence may be lengthened, and with the hope that by increasing knowledge lessening indications for drains may be found.

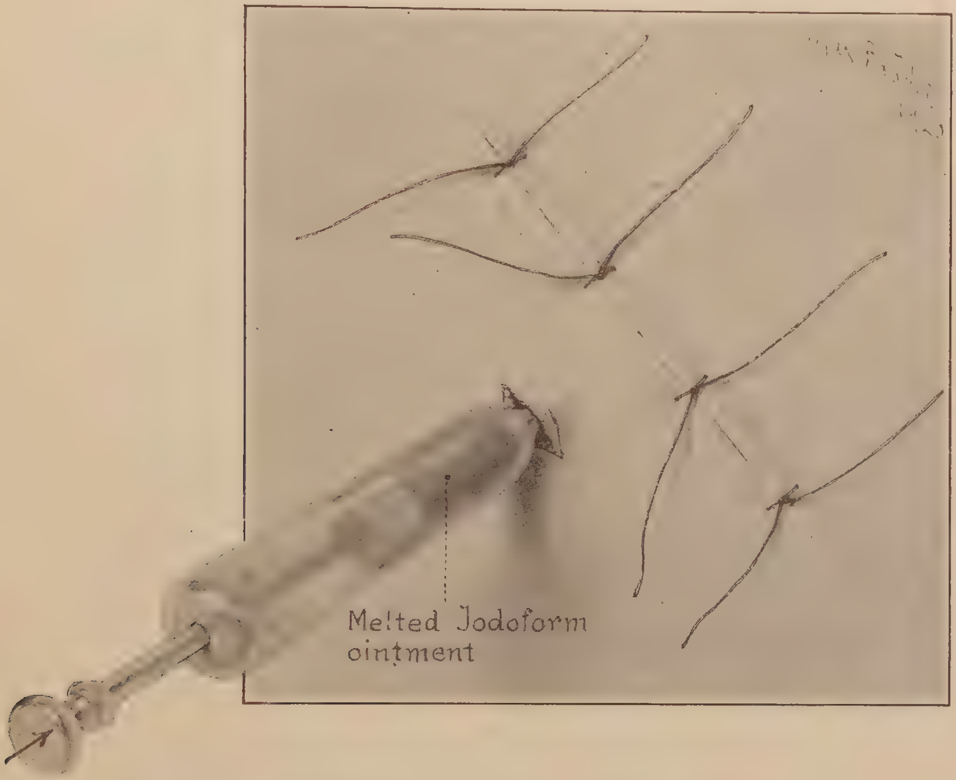

Fig. 49.—Injection of Melted Iodoform Ointment.

It is quite as much of an art to master the subject of drainage as to become expert in performing the operation. Undeniable as it is that many unnecessary drains are employed, yet no license obtains for undiscriminating operationists blindly to grope their way, or for undisciplined routinists to operate at all.

How to Drain.—When drainage is needed it should not be done in a half-hearted manner; it should be thorough and effectual. Most necessary is a sufficient opening for the exit of the substance to be drained. Further requirements concern the material of the drains themselves, methods of placing them, and postures of the patient.

Drains should be loosely held in their abdominal wall openings so as not to constrict them or interfere with the capillary flow. When they protrude through the wound, as will be most often the practice in right rectus incisions, sutures should be lightly placed and not tied too close to the drains. In stab wounds, made alongside the incision or farther away from it, useful in the McBurney type, stitches are seldom needed so that the drains may come through unimpeded. Stabs are made at various points: just above the pubes when the pelvis is to be drained, to the outer side of the incision when the iliac fossa is the objective, and high up in the right flank when retrocecal drainage becomes necessary (Fig. 51). The incision also may be left open or drained in the customary way. But in most instances it can safely be closed and kept intact, if its edges are protected during the operation and tight suturing avoided. The object of stab drains is to save the incisions, and thus prevent postoperative hernia, as well as to shorten the period of confinement. Hernia through a small stab incision is very rare.

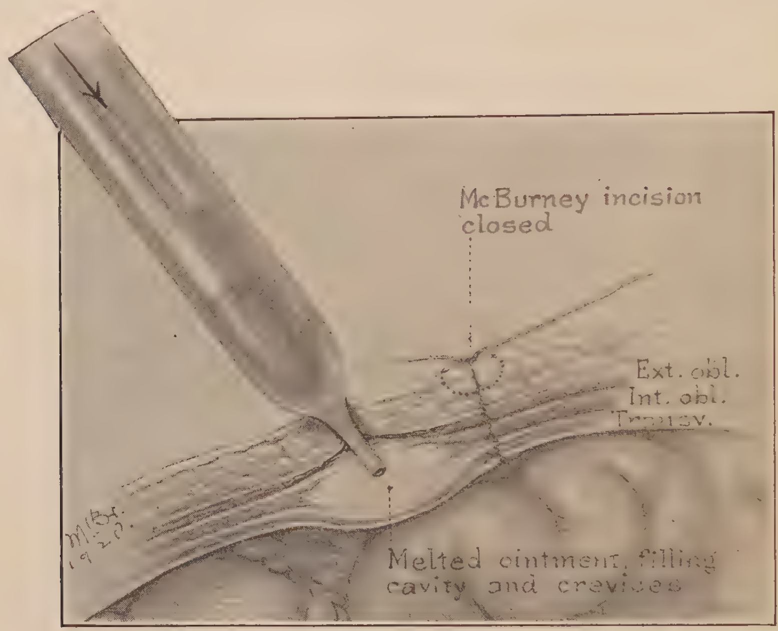

Fig. 50.—Manner of Filling Abscess Cavity.

Material.—Material for drains varies from a single layer of rubber tissue up to stiff tubes. Rubber-dam in sheets, used by dentists, is the best quality. When rolled in several layers it makes an excellent drain. The flimsy thin substitutes for rubber-dam are useless and sometimes harmful from cracking and breaking. "Cigarette" drains may be made by rolling a strip of gauze tape, of larger or smaller caliber, in the rubber material, with one end protruding, if desired. This acts as a wick and increases the capillary attraction. Collapsible soft rubber cylinders are often used instead of the rolled rubber-dam. They can be filled by pulling gauze through them. Gauze alone has long been discarded as a proper drainage substance. There are many objections to it, chief of which is the fact that so often it ceases to act as a drain and becomes a stopper.

The only recent relic of extensive gauze drainage is the Gibson-Mikulicz tampon. A report by Farr presented no comparative statistics of value, but he was quite sure from observation over a period of years and a considerable series of cases, that the Gibson tampon does lessen the mortality in the very severe type of cases; that it reduces morbidity and suffering and that the number of postoperative hernias is not greater than in other forms of treatment; that the hospital stay is no longer; that the conditions of the wound and the intraperitoneal relations are better than by any other form of drainage. A later estimate gave 17 to 18 per cent of hernia in the right rectus incision employed in these cases. Webb and MacFarlane used this method of drainage in four cases. They found it valuable in deep retrocecal abscesses; effective in keeping the intestines and omentum from the wound; useful in affording abundant drainage, preventing necrosis of fascia, lowering mortality, allowing other forms of simultaneous drains. They define the plan as "mercifully comfortable" and declare that the possible occurrence of hernia is not to be considered, as it is easily repaired.

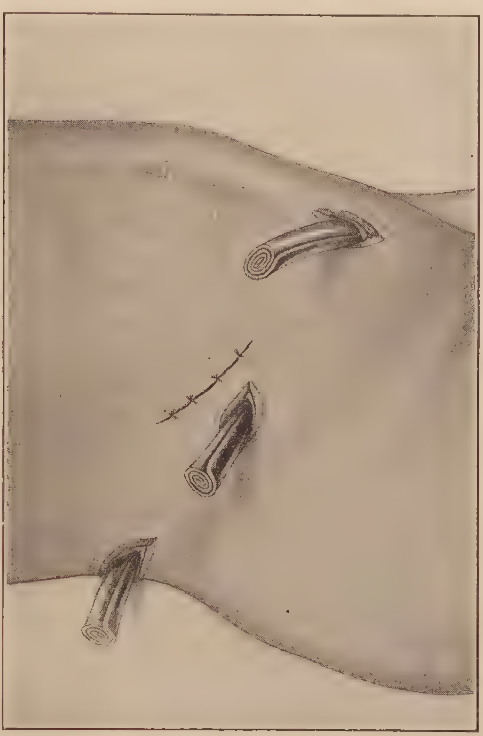

Fig. 51.—Three Different Locations Shown for Stab Drains: Suprapubic; to Outer Side of Incision and in Right Flank.

The rubber tube, soft or rigid, is commendable when drainage is to be maintained for a long period and when it is desirable to use irrigation or injections in the drained area. The tube may be split and a strip of gauze introduced to give greater freedom of attraction. Glass tubes, formerly much in vogue, are now used by only a very few surgeons. They have been known to break within the wound. There seems to be no sound reason to continue their use.

A unique composition for a drain was found very comfortable and effective in Moore's hands. He made it up as follows: Strips of iodoform gauze, 1 inch wide and 36 inches long, were packed into bismuth carbonate paste (33½ per cent), and six to twelve pieces put into the same vessel. This vessel was put into a basin of water and boiled for an hour (water bath), and put away until needed. Before operation it is again heated up, the gauze removed, soaked in the paste, which solidifies at the air temperature. A section of rubber tubing is carried into the wound as far as the peritoneum and stitched in place. Through this tube the gauze-paste drain is inserted down to the desired point. The advantages are: good drainage at once, no dry area to become soaked and therefore little if any febrile reaction; paste-drain has marked bactericidal properties; no adhesions to intestines, easy to remove, does not cause fecal fistula.

Methods.—Drainage through the posterior abdominal wall onto the loin or by the way of the flank has found favor in the hands of some operators. In very deep retrocecal abscesses this method is effective. Difficulty may be encountered, however, in getting through the thick lumbar muscles; it is much more convenient to make an opening between the anterior and posterior groups of muscles, and to pull the drain through close above the crest of the ileum. The drainage then will be less posterior than lateral, but perhaps quite as practical. Gravity effect, while apparently of great advantage, is not absolutely essential to success in drainage. By capillary attraction, by reversal of lymph-current (Horsley), and by localization, drains act just as well uphill as by downward flow. But it is tempting and at times positively advisable to make use of posterior drainage in large retrocecal collections of pus. A suprapubic stab wound is to be used for drainage when purulent material is in the pelvis. It is best made by carrying the left hand through the incision along the parietal peritoneum and cutting down from the outside upon two fingers held against the abdominal wall low down in the midline. A tube or "cigarette" drain is then introduced into the opening, pulled through, and placed deeply in the pelvis by the fingers inside. The original incision may or may not be closed, according to the operator's choice.

When it is decided to drain through the chief incision, either alone or in conjunction with other exits, the drain is placed in the ordinary fashion to the infected area and the wound closed up to the drain, leaving sufficient room for its proper function. The drainage opening should be left at the upper or lower end of the incision, never at its middle. In the transverse incision the outer end must be chosen.

It is Bartlett's custom to treat the pus appendix by simple ligation with catgut and then with the long ends of this ligature to tie in a folded soft rubber strip upon the stump for drainage. This drain comes away when the catgut is absorbed—a matter of four or five days. It is considered a safeguard for the patient, if a fecal fistula should break through and occasionally this accident may happen when the appendix has been tied too close to the cecum. It might be fair to ask if this rubber drain, tightly applied to the stump, may not predispose to the formation of a fistula.

Posture.—As an aid to any form of drainage posture is of undoubted value. Dependent openings allow rapid emptying of cavities and afford prompt shutting off of septic areas. This principle is very commonly made use of in draining appendical cases.

Best known is the *Fowler position*—elevation of the head of the bed eighteen to twenty-four inches, or having the patient sit up at the same angle on a frame placed in the bed—along with a drainage tube passed through a suprapubic stab wound. This posture was designed to collect by gravity the infective fluids from all parts of the peritoneal cavity into the pelvis, where absorption is supposed to be less active and less rapid and whence the septic matter can be evacuated by means of the drain. Most surgeons everywhere employ this position. A few see no special advantage in it. Certainly the tube is soon shut off from the rest of the cavity and an isolated drainage area is formed, which might take place anywhere without a drain. My vote is with Brockman who claims "the only indication for the use of a drain to the pouch of Douglas is the presence of an abscess cavity in that situation at the time of operation."

The *right lateral position* is of distinct importance in some cases. When the true iliac fossa is drained either through an incision or a stab wound far out, good results are obtained by keeping the patient on his right side, both for the purpose of continuing the localization of the infected parts and of securing dependent drainage. By propping him with pillows the patient can be comfortable in this position at an angle of 45 degrees or more. There is no question of the efficacy of this posture. Ochsner discovered its value accidentally. In the same room he had two patients, both cases of appendicitis with drainage; the bed of one was so situated that its occupant was almost constantly on his right side with his face to the door, while the other was compelled to lie on his left to look toward the door. Drainage was freer and recovery was more prompt in the former case. Reasoning from this observation caused an order to place all such patients upon the right side immediately following operation. Those who follow this procedure will not be disappointed.

Lying upon the face, or flat on the abdomen suits many cases in need of drainage by gravitation. It has been referred to as the "St. Louis" position, probably because of its original and frequent use by surgeons in that city. The patient may be supported by cushions under the chest and thighs, lifting the abdomen off the bed. Twenty-four to thirty-six hours is long enough to maintain the position. Both this and the previous posture are particularly expedient when the transverse incision is employed.

Removal of Drains.—Wide variation of opinion and practice exists concerning the proper time for the removal of drains after appendicitis operations. There are those who keep them in only a few hours and those who cling to them for many days. It would seem safer to err in the way of leaving them in too long rather than in that of taking them out too soon; for there are more residual abscesses as the result of the former course than intestinal obstructions due to the latter. As an effect of experience my inclination now more and more is to allow drains to stay in longer than was my previous custom, and my impression is that this is the better plan. But they are removed gradually; after a few days the drain is pulled up at each dressing and an inch or more cut off. Composed of the proper stuff and made in the right way, drains should come out easily and painlessly. There are times when a drain should be taken out early. Sometimes the wound drains more freely without the drain. The kind and amount of discharge, the type of infection, the general condition of the patient are factors in deciding the disposition of drains. It has been said that a good surgeon is "one who always knows when to put in and when to take out a drainage tube."

The Problem of Drainage in Acute Appendicitis.—An important contribution to this question is a recent article by Brockman. Entering upon an historical review of the matter, he referred to the era of domination by "an obsession that a peritoneal exudate of purulent appearance is of necessity pus demanding drainage," but felt that in the past few years there is a trend toward doing away with drainage in appendicitis as far as safely possible. The main advantage of a drain in diffuse appendicular peritonitis, he finds, is the "hypnotic influence of the drainage tube on the surgeon himself." No amount of drainage will make up for a lack of general resisting power on the patient's part. The disadvantages of drains are seen in frequent fecal fistulas, predisposition to acute intestinal obstruction, formation of residual abscesses, unpleasant and lengthy convalescence. The resistance of the peritoneum to infection is explained on the theory of lowered or absent tension, when the fluids pour out into the cavity, preventing destruction of the cells by pressure. The loose attachment of the peritoneum in the pelvis accounts for the greater resistance in that region. An intact peritoneum is necessary to close the abdomen without drainage.

Brockman's indications for drainage are in substance: most always in cases ill longer than three days; in children under twelve years, as a rule, for the peritoneal exudate in their cases constitutes a "potential abscess"; in cases of extreme toxemia, evidenced by the facies and the appearance of a peculiar cyanosis without dyspnea. Other factors are the nature of the infecting organism and the character of the peritoneal exudate. It is believed that neither the number of bacteria nor their type has any bearing upon drainage, but that the condition of the exudate carries weight. The larger the amount of fluid in the peritoneal cavity the safer it is to close without drainage; but a gangrenous appendix with diffuse dry peritonitis, a blood-stained purulent material, a beef-tea exudate, a cyanotic appearance of the bowel, thrombosis and abundant coagulated lymph in the omentum all demand a drain.

A method of draining each layer of the abdominal incision, after Eisendrath, is described by Brockman. It is designed to preserve the integrity of the wall after closure of the peritoneum and is similar to the technic used by many other operators.

The basis of the whole matter is to determine "what really constitutes the power of resistance to infection." With an abundance of this the patient will recover with or without drainage; with an absence of it, the opposite fate is due. As Brockman concludes: "If we so attempt to deal with the problem of drainage in acute appendicitis, we shall lose the feeling of suspicious awe on hearing of cases of diffuse purulent peritonitis from this cause when closed without drainage, and our outlook towards this branch of surgery will best be described by the words of the prophet of old: 'Why then is not the wound of the daughter of my people closed?' "

The best methods of drainage had been discussed previously by Love, who outlined four essential principles involved: (1) Drainage should be dependent whenever possible. (2) It should be along the most direct route. (3) The risk of secondary hemorrhage must be borne in mind. (4) The abdominal wall should be weakened as little as possible. He divides cases that need drainage into two groups—generalized infection of the peritoneum and localized abscesses—finding best results in the former from closure of the primary wound (either right rectus or gridiron) and the insertion of a suprapubic drain, and in the latter from a McBurney incision, with a stab drain in the loin or flank. Using these plans, he finds diminished stay in the hospital, less postoperative hernia, fewer fecal fistulæ, obviation of secondary hemorrhage, smaller percentage of mechanical ileus and, best of all, a reduction in mortality. While the gridiron incision is the one of choice, Love generally employs the right rectus approach in recurrent cases and in those of doubtful diagnosis.

In the 269 cases of acute appendicitis reported by Truesdell intraperitoneal drains were introduced 139 times. Folded dental rubber-dam was employed in all instances and through the incision, except in an occasional case when a stab wound was made. A remarkable feature is that in the entire series of cases no fecal fistula developed and no ileostomy was performed.

From the results of his own work and the reports of authorities Kendig draws the obvious conclusion that "the use of a drain in the abdomen is limited" and that "primary closure of the abdomen is, therefore, the method of choice, unless there is a specific indication for drainage." These indications are defined by him as follows: "(1) necrotic tissue, or localized focus of infection, (2) intra-abdominal pressure, (3) exposed extra-peritoneal or oozing spaces, (4) intra-abdominal abscesses." All abdominal conditions, he states, except those in which drainage is particularly demanded, will do better with closure of the incision. In addition to the usual disadvantage of a drain he mentions secondary infection from the outside and the attachment of the omentum to the adhesions around it.

The time for *removal of drains* seems to have undergone changes and various opinions have been expressed at different times. Bartlett's custom is to remove drains within twenty-four hours, since they favor fistulæ, and press upon large blood-vessels. Heyd advised removal of a drain at the end of thirty-six hours, if the patient's pulse and temperature had dropped. Bratrud uses several types of drainage; when the packed rubber glove is employed, the packing is gradually removed after forty-eight hours. He is quick to drain, doing it "in every case where a green or black spot shows on the appendix." Gatch and Durman were partial to sheets of rubber frequently placed "so as to form a complete cofferdam about the dangerous area," removing the central drain in twelve hours. Cigarette drains carried down to the retrocecal fossa by Muller are usually removed by the fifth day. Care in placing drains, he believes, prevents intestinal fistulæ. Occasionally he institutes drainage through the loin. Truesdell did not withdraw drains entirely until seven or eight days after operation.

Pardonable comments upon these matters would include a suggestion that cases recovering without incident after twelve to twenty-four hours' drainage might have done just as well without drainage, and a statement that if drainage be done for a green or black spot on the appendix few cases of very acute appendicitis would escape drainage. The tendency seems to be toward leaving drains in longer for the prevention of further abscess formation. Many secondary collections of pus occur at a distance from the original focus and are not connected with it; some of them, however, develop in the depths of the drainage tract, burrowing to other areas, but still tributary to the primary cavity. These can always be drained through the external opening, if the rubber-dam or tube be not removed too soon, allowing the fistulous canal to close below and shut off the secondary purulent mass.

Residual abscesses are only too frequent in children whose peritoneal tissues are nonresistant. But they occur in adults and may point in any direction. Bennett reported an unusual case. His patient, a man of forty years, was operated upon for gangrenous appendicitis. Three weeks after removal of the appendix an abscess formed outside and below the peritoneum, and to the left of the rectum, draining into the bladder. At the operation the pelvis was drained through the incision. Gangrene of the fascia occurred, pus invaded the muscles and the infectious material seeped into the area where the abscess was located. To avoid this Bennett proposed sewing the edges of the peritoneum to the fascial layers. Such abscesses as here recorded are seldom seen; those in the true cavity of Retzius are not so uncommon.

This complication might supervene under any conditions, but it would seem less likely to happen if external drainage be kept up until the danger of infiltration were past. It is not stated in this instance how long the drain was in place.

REMOVAL OF THE APPENDIX IN ABSCESS CASES

The question, whether the appendix should be removed in all cases of walled off abscesses or in cases of peritonitis limited by adhesions, has furnished the subject for many debates. The generally accepted practice is that, when removal of the appendix necessitates breaking down barriers of adhesions or undue trauma to any tissues or organs, it would be wise to leave it; but, if it is accessible and readily manipulated without seriously disturbing the neighboring parts, it would be better to take it out. There are no specific rules to be laid down. Personal experience is the guide. There are some operators who are always inclined to drain and get out in the presence of pus and adhesions, when the appendix is not easily and promptly exposed; they are acting within their limitations and are doubtless choosing the right course. Other operators endowed with keen judgment and consummate skill would search for the appendix in the same type of cases, and remove it speedily and safely. They are also following the procedure which best fits their talent and temperament. Mistakes are made in both directions. There can be no doubt that taking the acute suppurative cases as they come, in the vast majority of them the appendix may be and is safely removed. In the abscess case, completely walled off, the insertion of a drain is all that should be done; in the peritonitis case, dammed back by adhesions involving the appendix, the procedure may be varied, according to luck in locating the appendix, and peeling it off gently within the infected area or finding it wedged into dense exudate attached to the small bowel. When the adhesions are yielding and not protective, in the presence of free pus or of other purulent pockets beside the abscess in view, it is proper to break up the inadequate boundaries, remove the appendix and treat the case as for a general abdominal infection. In very severe cases when patients *in extremis* exhibit a peritoneum full of pus, the only recourse is a quick opening under local anesthesia, if possible, and the insertion of drainage, without looking for the appendix. Even here, however, the appendix occasionally bobs up into the incision and may be seized and tied.

As stated, much depends on the individual surgeon. Lower and Jones are of the opinion that the high mortality in acute appendicitis is due in large measure to the common belief that in every case the only proper procedure is the removal of the appendix; they insist that appendicitis with associated peritonitis is a systemic rather than a local disease. Deaver holds that "in practically every case the appendix can be removed." Gatch and Durman removed the appendix in every instance of their 205 pus cases. Wolfson and Morse failed to remove the appendix in only two cases out of one hundred of the severe acute types of appendicitis—one on account "of the poor general condition of the patient" and the other because of "the futility of freeing a badly degenerated organ."

It is rarely that I fail to remove the appendix in any of the suppurative types of appendicitis encountered in my clinical work. To speak definitely it was left twice in the last 220 cases. The run of cases points the way. Other operators, perhaps, might have refrained from removal more frequently. In no case of our own did the decision seem to affect the result.

Leaving the appendix in produces very little trouble afterwards, if it is completely gangrenous, or sloughed away; but, if it has perforated through a small opening which still remains or is intact with suppurating walls, secondary symptoms may be expected. It is estimated that 20 per cent of unremoved appendices will light up after drained abscesses. An important problem arises in relation to what further steps should be advised following recovery from drainage with the appendix retained. Bartlett characterizes the experienced abdominal surgeon as one who follows the rule of Kocher in such cases to wait six months before attempting interval appendicectomy, for the reason that, not until this lapse of time, have the anatomical difficulties, which originally precluded removal of the appendix, so completely disappeared as to permit the operation to be done with safety. In a few cases the drainage tract does not heal and a persistent fistula remains. Not all of these require secondary operations; occasionally they cast off the obstructing mass—fecalith, appendix stump, etc.—and close spontaneously. It is my custom to give such cases a chance to clear up; for, if they do not, they only become chronic in type and, with the establishment of immunity, are safe risks for subsequent interference.

Apropos of *recurrences following appendical abscess cases* in which the appendix is not removed Reschke disagrees with reports that these seldom light up afterwards, as he experienced a return of symptoms in 46 per cent among five hundred instances. He observed little difficulty in the secondary operations, practically always found the appendix (failing only twice in the whole number), noted that as a rule the appendix was fairly long. In eleven cases with no recurrence of symptoms but submitted to interval operations, the appendices showed stenoses and obliterations always at the distal end. Reschke concludes that terminal obliterations are harmless, while a proximal stenosis is dangerous; that interim operations are advisable and absolutely necessary if the patient contemplates travel away from prompt surgical assistance.

Duettman favors the two-stage operation in appendicular abscesses. He quotes figures from the Giessen Clinic to the effect that in 367 cases treated only by evacuation of the abscess there were three deaths, 0.8 per cent mortality; of the 314 patients (86 per cent) who came to secondary operation, there was just one death, 0.3 per cent mortality; a total mortality of 1.09 per cent—very low as compared to the results of the one-stage operation. Duettman finds that new attacks of appendicitis are not rare when the appendix is not taken out at the original operation. The cases reviewed by him were 285 (78.3 per cent) that came for secondary operation after three or four months. Eighteen returned later and were operated upon under a diagnosis of acute appendicitis. Of the first total, there was obliteration only in eleven; acute inflammation in sixty-five; chronic in seventy-two, these showing in one-third of the cases closure of the appendical base and pus distending the outer portion. In seventy-three of the whole series the tip of the appendix was obliterated, but the mucous membrane was still intact towards the inner part. Even in cases operated on two or three times for recurrent abscesses the appendix was found well preserved, showing that complete obliteration is not always obtained.

APPENDICECTOMY IN THE COURSE OF OTHER ABDOMINAL OPERATIONS

Whenever the abdomen is opened for the performance of any operation the removal of the appendix naturally comes up for consideration. Shall the appendix be taken out in every instance? Shall this be the routine practice without regard to its condition, whether it is abnormal or not? Only a few more minutes are required; the appendix may be easily secured; its riddance may save trouble in the future, even if it be not now diseased.

Response to these queries will involve the judgment of the individual surgeon. He will decide these problems as he comes to them, or he will adopt a regular plan derived from his own experience. Better not a routine in every case. "Every" is a strong word. It affords no outlet for exceptions. Suppose, then, we say that the appendix must come out when it shows evidence of disease; who is to be the unerring judge of its status? Are kinks, adhesions, external appearances to be the signs of disease? Or shall we depend upon viewing the interior of the appendix? Of course, there are definite tokens of appendicitis; but are they to be satisfyingly prominent before appendicectomy is demanded in these circumstances? Personal inspection and opinion would seem to be the sole criterion.

The question of removing the normal appendix is a very weighty one. In the chapter on Physiology it was pointed out that the appendix may have a function, and that a significant suggestion concerned its action in promoting the peristaltic motion of the cecum and colon. This office is inherent in the normal appendix; the diseased appendix fails to perform it. It is reasonably well established that excision of the normal appendix produces constipation in many individuals, or increases that which is already present. But who again will decide which is the normal and which the abnormal appendix? It may be normal in appearance and abnormal in function, and vice versa. In the chronic types of appendicitis pathology and clinical signs do not always correspond.

True, just a few minutes extra are needed to get rid of the appendix and in a clean field the danger is almost negligible. But there is a slight risk: a lapse in technic can occur; time may be an element in the total operating period; accidental sequelæ are not unknown. Another matter of concern is the patient's consent. In the presence of a pathological appendix the surgeon would be justified in acting upon his best judgment regardless of previous arrangement; in the event of what appears to be a healthy appendix, there might be some question of the procedure. Hardly any one could seriously object to removal of the appendix under any conditions. In rare instances, however, the situation might arise and medicolegal complications might ensue. Upon request of the patient or his responsible relatives and friends, it would surely be proper to take out the appendix, no matter what its condition, provided explanations be made beforehand.

As a matter of anticipatory or preventive surgery the appeal would be powerful to remove every appendix when the abdomen is already open, but not always so overwhelming as to discount the doing away with a normal structure. Nor would I consider for a moment the performance of an appendicectomy, if this additional procedure, however simple and brief, would seem to endanger in the smallest degree the success of the main operation. This would include prolonged manipulation, extra incisions requiring delay, diffusion of infective material and additional unforeseen difficulties. On the other hand, by special solicitation of the patient with a normal appendix, in cases with an evident diseased appendix, in all cases which present an adherent appendix or one that is associated with the major lesion for which the original operation was done, I would unhesitatingly perform an appendicectomy. Examples of the two last events are exhibited, first when the appendix is adherent to the pelvic organs—tumors, inflamed tubes and ovaries; second, in the case of the appendix connected with gall-bladder infection, whether the former at the time appears healthy or not. Above all I could not support the view that always the appendix must be removed whenever the surgeon has the abdomen open for any purpose. As a rule the appendix should be palpated and inspected, if feasible. As a matter of fact numbers of appendices are removed during the course of other celiotomies. Many operators do not balk at taking out the normal appendix, with doubtless good and sufficient reasons on their own account. And a large proportion of appendices are said to be abnormal, microscopically if not macroscopically, although the clinical symptoms may be absent. Actually, then, a great percentage of the appendicectomies under these conditions are justifiable, coming fairly within the types portrayed from my personal experience.

In abdominal operations for diseases of the pelvic organs in women special significance attaches to the question of the concomitant removal of the appendix. It may be independently diseased; it may be involved in the pelvic pathology; it may be healthy in itself, but present for decision. It is here that the greatest number of appendicectomies occur. A series of 405 cases was analyzed by Beuttner. Of these, the appendix was found macroscopically normal in 314, but was removed any way; in forty-two cases the appendix appeared abnormal to the naked eye, but was not removed, either because of the severity of the gynecological operation or the fear of causing further shock; in twenty-seven instances the appendix showed positive disease and was removed; the condition of the appendix was not definitely discovered in 121 operations on account of difficulty in locating it and the desire not to protract the procedure. A previous report by the same writer contained one hundred cases removed in the course of pelvic operations, studied on a microscopic basis. Sections of these demonstrated that thirty-seven were normal and sixty-three presented changes varying from traces of mucosal inflammation, to acute and chronic types with obliterations in three instances. Beuttner's views are in accord with those of Schauta and Wertheim that "routine appendicectomy in gynecological laporotomies is not justifiable." He believes that it complicates the pelvic operation and tends to exert an unfavorable influence on the operative course.

POSTOPERATIVE CARE OF THE PATIENT

Obviously the conduct of the case following operation will depend upon the type of the disease. In the chronic case, or the clean acute case, the treatment will differ radically from that to be carried out in a drainage case, whether it is a localized abscess or a peritonitis, confined or diffuse. Attention to complications also becomes a necessary part of the postoperative care, whenever these accidents arise. Generally the less done to the patient the better. Many suffer from overtreatment. In the uncomplicated cases coming back to bed from the operating room the immediate need is quiet and a good nurse during the period of reaction. As soon as the patient arrives at the stage of conscious interpretation, he may be given morphia by the hypodermic syringe for pain; 1/12 grain, repeated very often, every half hour if necessary, is usually sufficient and much better than larger knock-out doses given far apart. Cracked ice and water may be freely administered. Bicarbonate of soda, 30 grains at a time, given in a little water every three or four hours is grateful to many and a chemical adjuvant to all. The patient is made to change his position frequently. This is the sum and substance of our regular orders for the first twelve to twenty-four hours.

If the patient has been starved for several days before the operation or cannot retain liquids afterward by the stomach, a rectal infusion either of tap water, normal salt solution or a mixture of soda (3 per cent) and glucose (5 per cent) in water, according to the severity of the symptoms, is administered, interruptedly or continuously. When these are not retained or when additional fluids are needed normal saline solution by hyperdermoclysis is given.

Thin liquids by the mouth are allowed on the day following operation and on the succeeding day heavier liquids of any kind. When "gas pains" develop as they may during the first forty-eight hours even without marked distention, the following directions are advised, in succession: mustard paste or hot camphor stupes on the epigastrium; insertion of rectal tube; colonic irrigation with normal salt solution; 10 grains of quinin muriate in a half pint of water by the rectum to be repeated in four hours if necessary. This process is to be repeated in the same order, if no relief is obtained or if the gas pains return after being once relieved. The use of morphin is not to be kept up during this treatment unless the pain is still severe at the end of the procedure, when a hypodermic injection of hyoscin 1/100 grain, would better be given, guarded with 1/12 grain of morphia.

If the abdomen should become greatly distended, with little or no pain eserin salicylate 1/40 of a grain hypodermically, every three hours for three doses, followed by an alum enema (1 ounce to 1 quart of water), is very effectual. In my hands eserin has proved superior to pituitrin, which is usually given by hypodermic in one large dose, giving at times a prompt response with more or less instant relief but failing in any lasting effect according to our observation. I also regard the action of pituitrin as too quick to be safe. Experiments made by Cross on isolated human appendices suspended in Locke's solution, kept at a temperature of about 37° C., yielded these deductions: (1) Eserin and pituitrin in combination have a more powerful effect in stimulating movements of the intestine than either drug alone. (2) Many cases of severe postoperative atony responded to this synergistic association when the exhibition of each remedy singly gave no relief and failed in none unless an unsuspected mechanical ileus was present. It is suggested, therefore, that smaller doses of these substances given together are much more successful than large doses of either given separately.

Deaver gives $\frac{1}{40}$ grain of eserin every hour for six hours, with $\frac{1}{60}$ grain strychnin with the first third and sixth doses. He does not use pituitrin, considering it a dangerous drug.

On the third day the bowels may be moved by purgative or enema, preferably by the latter method unless there be substantial need for complete through-and-through evacuation. Immediately soft diet can be taken. The food is gradually increased in quantity until regular diet is reached on the sixth day. A back-rest in bed is ordered for the fifth day and the patient is out of bed in a chair on the seventh day. The external stitches are removed about this time or a little later. The wound is not dressed until this is done, unless pain or temperature points to infection.

Such is the regular program for a normally convalescent patient after a clean appendicectomy. It is not held to be the only way nor the best way. At least it has the advantage of simplicity. Other plans are just as good. Variations of the above plan are made if necessary and entirely different methods are substituted whenever good judgment indicates.

When it comes to taking care of the cases needing drainage the schedule is changed to suit the conditions. Use is made first of whatever posture will conduce to free discharge through the drain opening. The Fowler position is the one most universally employed and in spite of some adverse criticisms and some deserved objections on theoretical grounds, it still remains the best practical aid to drainage, and often the most convenient and comfortable position for the patient. Other postures, however, merit larger use in eligible cases: the right-sided decubitus when the infection is situated entirely outside the cecal area; ordinary dorsal position if the involved portion is confined to a small space at or near the ileocecal area, or in the event of drainage through the loin; the prone state to favor prompt and direct emptying of the cavity.

In conjunction with advantageous posture, introduction of water into the patient's system must be pushed through the medium of the rectum, the skin or the vein, using plain water, the normal saline solution or combinations of alkalies and sugars—all according to the gravity of the case. To get sufficient fluids into the circulation is the prime vital necessity in the cases suffering from prolonged suppuration or starvation with the consequent acidosis syndrome and a very present help in the fight against overwhelming acute peritonitis.

Furthermore in this class of cases all nourishment by the mouth must be withheld in accordance with the Ochsner idea, until the peritoneal infection has subsided, and the stomach-tube is to be used as often as demanded. Many, many times this is a life-saving measure. Morphia also is of great benefit and is not to be denied. In some cases it will predispose to nausea and nearly always it increases the gaseous distention of the abdomen. Transfusion of blood is performed in certain types of general infection following perforative appendicitis, but, in my experience, with slight, if any, good effect.

So-called stimulants are resorted to by some surgeons in the treatment of appendicitis cases doing poorly after operation from anv cause. Such drugs as strychnin, digitalis, caffein, camphor, adrenalin, and others are used in shock, infection, obstruction indiscriminately and in certain quarters splendid results are attributed to them. Except in definite cases of pure surgical shock, in which some of these remedies given in not too large or frequent doses seem to be helpful, we have not found the usual stimulant drugs to be of much avail. Their tendency is to overact and to bring about just the very result we are seeking to prevent—whipping up a tired heart, exciting peristalsis. The best "stimulants" are rest, morphia, water.

Lower and Jones believe in the Fowler position after operation, plus the Ochsner treatment, plus the Alonzo Clarke method for peritonitis, plus the application of large hot packs over the abdomen, plus hypodermoclysis, and stick closely to the Crile principle of confining the primary procedure to incision and drainage if the appendix is not accessible, reserving appendicectomy for a secondary operation after the acute stage has passed.

Radical departures from the methods described are practiced by numbers of surgeons in all parts of the world. Good results are claimed by those who use exactly opposite methods, so that one might doubt whether there is anything essential in any plan. Numbers of patients would go on to recovery after appendicectomy with postoperative care beyond the ordinary attention and watching. Even in the majority of cases a good motto would be, "Let the patient alone and let him get well." Yet it is in the exceptional case, apparently doing well, that trouble may arise demanding the highest judgment to discover and the greatest skill to combat. Such disturbing affairs constitute the postoperative complications which have been heretofore described.

There are surgeons who close their McBurney incisions loosely, with no sutures on the internal oblique muscles; or those who use adhesive plaster on the skin instead of stitches. Others give an abundance of morphia or none at all. Muller gives morphin in mild cases every six hours and in severe cases every two hours, until the respirations are reduced to twelve per minute. Some allow their patients solid food on recovery from the anesthesia, while others withhold even water for twenty-four hours. There are surgeons who get their patients out of bed soon after operation and up and around in a surprisingly short time. Reese has his "clean cases" up the next day for the following reasons: (1) They have no gas pains. (2) They avoid the bed-pan. (3) They develop no adhesions. I know a few others who come very near this plan, though they are perhaps not quite so precipitate in their views. Still a minority adhere to the old method of two weeks in bed. The golden mean is probably the safest practice.

Treatment of Complications.—Three classes of complications are seen following operations for appendicitis: (1) those occurring in the wound, as hematoma, infection, separation; (2) those within the abdomen, as secondary hemorrhage, peritonitis, intestinal obstruction, residual abscess, pylephlebitis, and others; (3) those outside the abdomen, as pneumonia, empyema, septicemia, phlebitis, etc.

These have been described in Chapter VIII. Their management resolves itself into the treatment of each particular condition as it arises. Wound complications are best attended to by conservative measures; pressure first and then evacuation of bloody collections through a small forceps opening; draining pus through a side stab and injecting sterile melted ointment, or application of hot antiseptic moist dressings without removal of stitches. Immediate resuture is indicated in the case of aseptic separation of an unhealed incision.

The extra-abdominal complications should receive prompt therapeutic attention. Measures for their treatment are to be employed as usual in such conditions occurring independently of appendicitis.

Of the intra-abdominal complications it will be expedient to refer only to those closely concerned with the after care of the appendicitis patient. In the main their treatment has been already taken up in our consideration of drainage, technic, posture, diet, and the like.

Peritonitis which is present at the time of operation is to be treated as outlined previously in the description of the suppurative cases. Peritonitis which results from extension of infection to other portions of the peritoneum, in drained or undrained cases, presents the same problem for solution. Adequate drainage, proper posture and supportive measures must be promptly secured. It may be necessary to reopen the original incision, or to make a new one, in the endeavor to reach the infected area. In diffuse septic peritonitis recovery is not to be looked for.

In any case of postoperative intra-abdominal hemorrhage the abdomen should be opened at once and the bleeding vessels ligated, whether they are found at the stump, in the mesentery or at some other unsuspected situation. Before going into the peritoneal cavity, it may be well to ascertain if the bleeding is not issuing from the incision. If the patient be exsanguinated blood transfusion may be needed.

Intestinal obstruction is an affair for prompt treatment as soon as recognized. We have already seen how difficult is the diagnosis, and we have referred to the management of cases of meteorism bordering upon obstruction. The paralytic type, coming earlier, is most confusing. Organic ileus, due to bands, kinks, adhesions, occurs later. The first variety is more susceptible to treatment and relief may be obtained by gastric lavage, enemas, hot stupes, posture and drugs for intestinal contraction. The second type is not only not cured by such means but made worse by the use of some of them and harmed by the necessary delay. Cases of dynamic obstruction demand early interference with release of the constricting lesion. About both varieties discussion rages sharply upon the indications for and the value of enterostomy. Some surgeons have a long series of successful enterostomies, while others have just as lengthy a run of losses following their performance.

There is no more perplexing problem than that of acute intestinal obstruction following an operation for appendicitis, and no more distressing question to decide than that of the proper time to interfere and the suitable method to employ. Paralytic ileus often may be relieved by nonoperative plans just referred to. Mechanical obstruction must be released by means of an opened abdomen. There is no very definite way of saying which is present at the onset. Generally there is severer pain in the organic type. In the uncertainty shall reliance be placed upon external means, or shall an additional operation be performed? This is the dubious game we are playing, and there are no rules. When he is not sure whether immediate operation should be done Deaver places his patient upon the Ochsner method and if there is no improvement in a few hours, he operates. If the condition clears up under this treatment, it is peritonitis only; obstruction will fail to show amelioration.

In order to afford immediate improvement, to tide over the critical period the operation of *enterostomy* was introduced. This signifies the opening of some portion of the intestinal canal, and draining out its toxic contents through a tube which is retained for a number of days. Various methods are employed and differing opinions are offered upon the value of the procedure. As a rule those surgeons who are accustomed to employ enterostomy early, perhaps in some cases when it would not have become necessary, obtain a high percentage of recoveries following its performance, and are thereby its enthusiastic advocates; whereas those who put it off and use it only upon pronounced indications or as a last resort, have an excessive mortality list and are consequently disappointed in the operation. Without the shadow of a doubt it has saved hundreds of lives, but the main question is to determine when it is needed. Many lives have been lost in spite of it, especially when it has been performed in meteorism due to peritoneal infection and not to paresis or to mechanical block. For enterostomy no "convincing indication" presented itself to Truesdell in 259 operations for acute appendicitis. He feels "a lack of conviction as to its efficacy." Concerning this operation he remarks—and who will not agree with him?—that "it is not a cure for peritonitis. The disadvantages of the procedure, both immediate and remote, are obvious. It has failed to save many patients; others might have recovered without it."

Seward Erdman reported three cases operated upon, two on the same day, with one death. His method of choice is a high jejunostomy done through an intermuscular incision at the outer border of the left rectus and a little above the level of the umbilicus. A soft rubber catheter is introduced for 3 inches into the bowel through an opening surrounded by a purse-string and depressed by sutures through the outer intestinal coat, after the method of Witzel. Credit is given to Victor Bonney for the idea of the "high" operation. He divided the obstructed intestine into three segments: (1) the lower, more or less collapsed; (2) the middle, distended with gas; (3) the upper containing fluid, the "zone of toxicity." It is explained that by reverse peristalsis the toxic fluid infected by the organisms from the large bowel extends rapidly into the upper segment, which is drained best by jejunostomy. Erdman charges the "low" (ileal) enterostomy with a high mortality (always present in peritonitic cases, he says) not only, but also with special failure to drain.

Handley's objections to jejunostomy are: (*a*) that it necessitates a second operation within two weeks for resection of the jejunum and (*b*) that it deprives the patient of much needed fluid and nourishment. He believes that Bonney was successful with most of his cases because they were of mild peritoneal infections or "non-inflammatory ileus following operations for the removal of infected cancers of the cervix."

After releasing bands of obstructing postoperative adhesions it is possible for a secondary paralytic ileus to occur, demanding further relief. Such a condition happened in a case of McFarlan's, who, six days after reopening the abdomen, was forced to do an ileostomy, which cured the distention and allowed free evacuations two days later, followed by recovery.

Another illustration is afforded by Hollace R. Royster, who had to perform two operations for postoperative intestinal obstruction, the latter occurring above an enterostomy made to relieve the former. A leiomyoma of the jejunum, probably causing volvulus, was found between the pylorus and the enterostomy opening, compelling resection of the intestine. A special feature of the case was the development of severe acidosis thirty hours after operation for closure of the enterostomy wound and its relief by intravenous administration of glucose and insulin.

The largest majority of enterostomies are done through the ileum. From the earliest recorded cases and particularly as performed by Nélaton in 1858 it has been the usual practice to open the abdomen in the right iliac region, either through the primary wound or a new incision, to draw up the first loop of intestine presenting, and suture it to the wound. Practically all such operations are done under local anesthesia. Many modifications in technic have been proposed. The objects to be obtained are saving time, protecting the peritoneum, prevention of subsequent leakage, prompt postoperative closure. Various devices have been designed to safeguard these conditions.

One of the first and foremost advocates of enterostomy in recent years was J. W. Long. In 1916, he proposed a technic, offered as a standardized type, the chief points of which were incising the intestine with a cautery point instead of a knife (Fig. 52), passing the drainage tube through the omentum and suturing it snugly around (Fig. 53), and the retention of the tube outside by two narrow adhesive strips (Fig. 54).

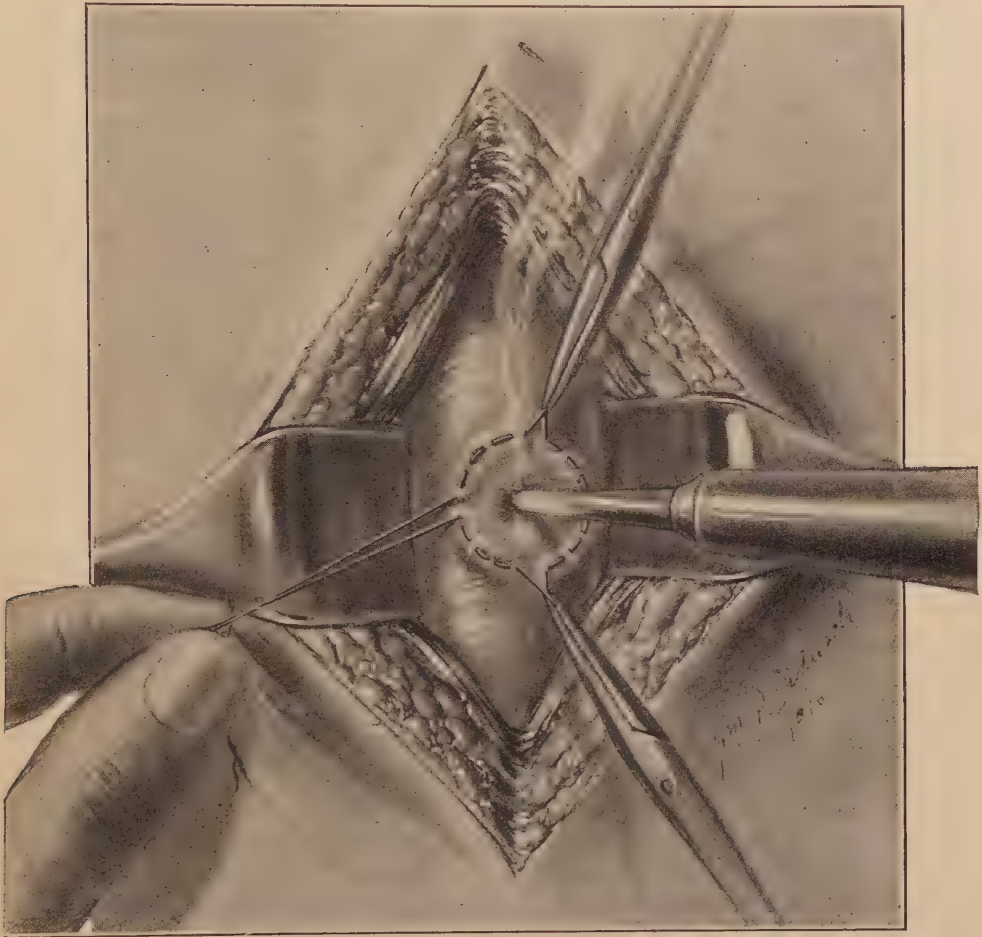

Fig. 52.—Enterostomy. Incising Intestine with Cautery Point after Applying Purse-String. (J. W. Long.)

Cecostomy is sometimes done in conjunction with ileostomy and both are employed at the primary operation for appendical peritonitis as a preventive of intestinal obstruction.

The value and importance of enterostomy furnishes food for discussion largely upon the question of mortality. Reference has been made to its influence in the early and in the late cases. Some surgeons have comparatively large numbers of enterostomies to their credit, while others have few or none, and yet the general mortality rate of their appendicitis work is about equal. It would appear that the types of cases are very different, or else that the operative technic of some is followed by more obstructions than that of others. Brooks, Clinton, and Ashley have great faith in enterostomy, having made this procedure in some form at the primary operation no less than sixty-one times in 378 cases of perforated appendix with diffuse peritonitis during the last five years. Plain enterostomy was done in twenty cases, cecostomy in twenty-six, and the two combined in fifteen. The number of deaths was seventeen. In eighty-five cases of enterostomy, thirty-three were done for

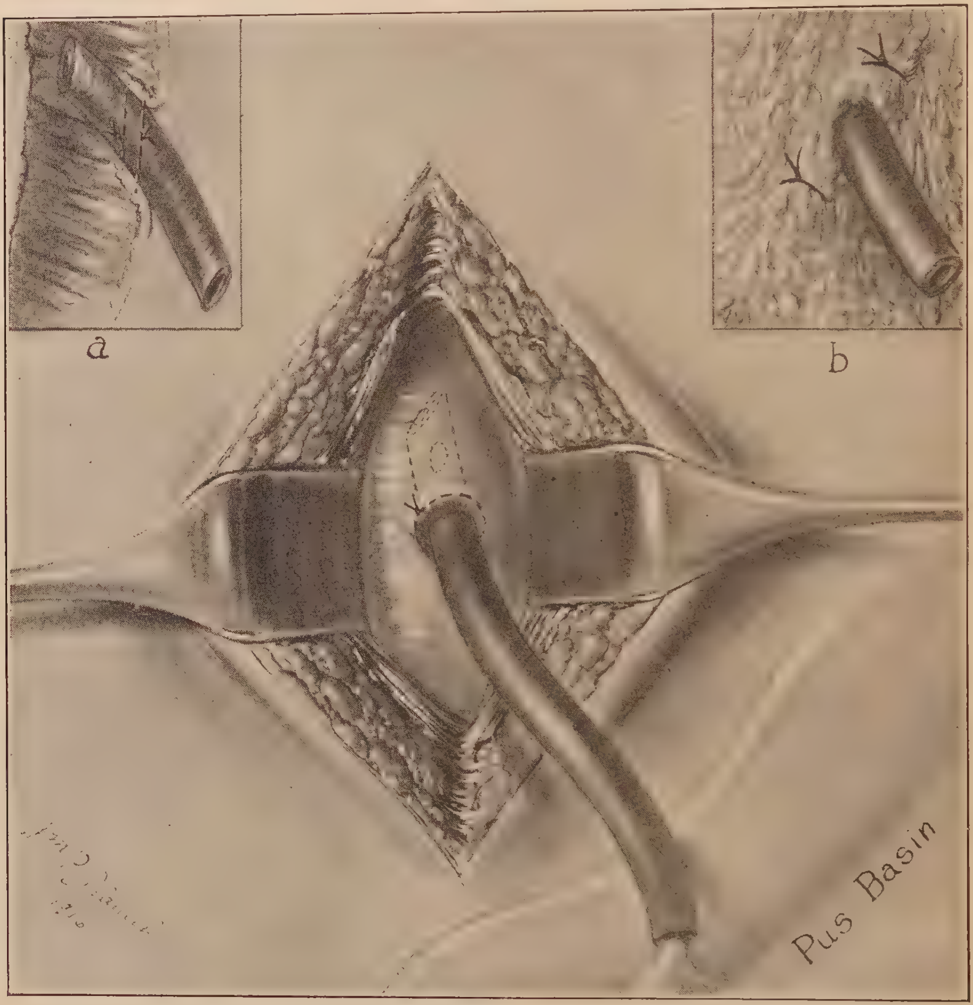

FIG. 53.—ENTEROSTOMY. SHOWING DIRECTION OF TUBE IN THE BOWEL.
a, position of tube in relation to intestinal wall; *b*, tube brought through opening in omentum which is stitched around. (J. W. Long.)

postoperative ileus with sixteen deaths and thirty-two for intestinal obstruction with thirteen deaths. These writers urge more primary enterostomies, claiming by this measure more than 50 per cent reduction in their mortality when peritonitis is present from a ruptured appendix.

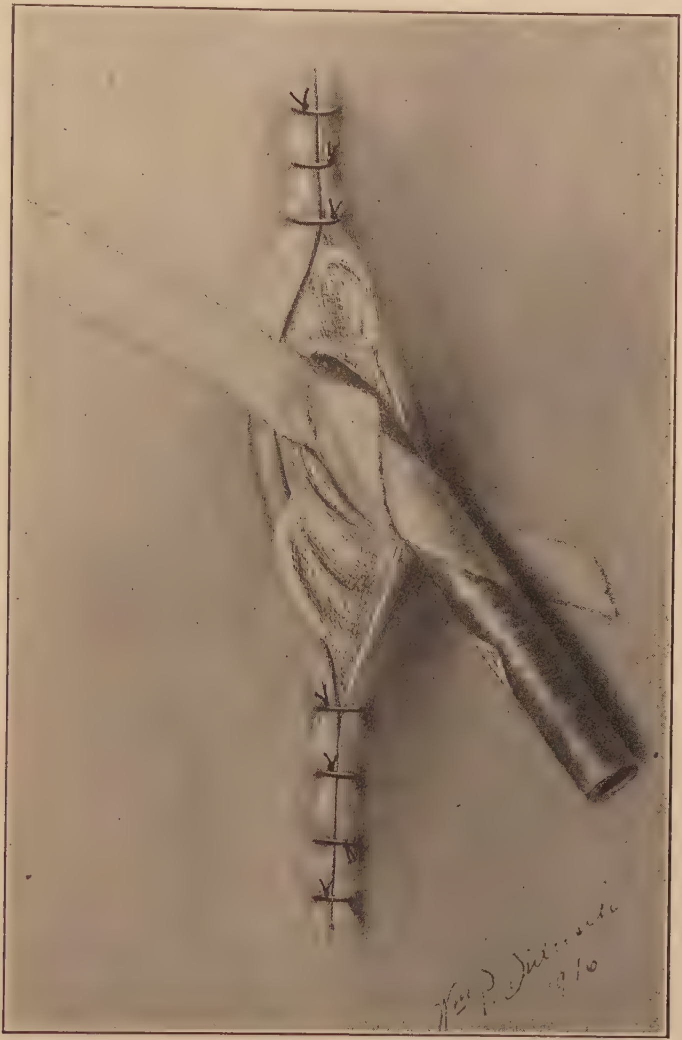

FIG. 54.—ENTEROSTOMY. RETENTION OF THE TUBE OUTSIDE BY TWO NARROW ADHESIVE STRIPS. (J. W. Long.)

"Ileus duplex" is a term applied by Handley to a paretic obstruction of the bowel at two locations described as follows: "(*a*) the ileum at a point about three feet above the ileocecal valve; and (*b*) in the sigmoid colon at the junction of its iliac and pelvic portions." These two parts of the intestine along with a gangrenous appendix are adherent in the pelvis, involved in a pelvic peritonitis and bathed in a pool of pus (Fig. 55). At the primary operation one should reach down and loosen the intestinal coils thus disposed and place a drainage tube in the culdesac. If obstruction occurs, Handley advises a secondary operation: an ileocecostomy when the pelvic stage only is present and ileocolostomy or jejunocolostomy if the hypogastric area is invaded. In most cases the best procedure is to anastomose the jejunum with the transverse colon and at the same time to tie a tube into the cecum (Fig. 56).

In the past few years Deaver has become more and more attached to the operation of ileocolostomy and sometimes in addition, one or more enterostomies, when knuckles of ileum are found plastered down in the culdesac. Long recently reported two cases in which enterocolostomy apparently saved life.

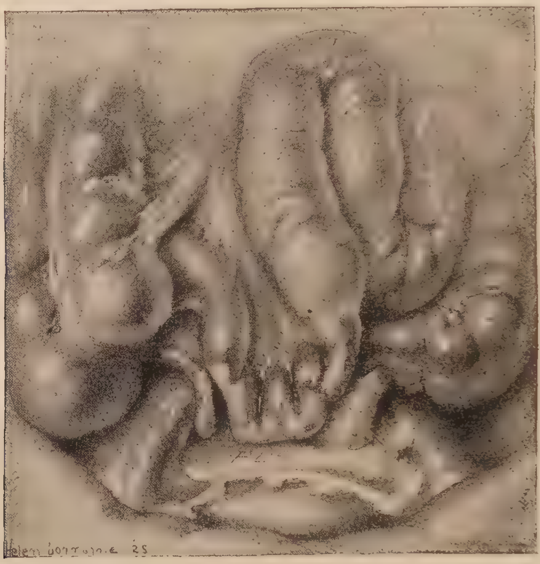

Fig. 55.—"Ileus Duplex." Obstruction in Ileum and in Sigmoid Flexure. (J. W. Long, after Handley.)

Obstruction occurring after the patient is fairly well on the road to recovery is due to kinks, adhesions, constricting bands, volvulus and the like, and not to paralytic ileus. Prompt operation is the only treatment to be considered. This type of intestinal occlusion may come on even years afterward and the first thought in obtaining the history in such cases should be to inquire if there has been a previous abdominal operation and of what nature.

It must not be forgotten also that intestinal obstruction can come on following operation in cases of *chronic appendicitis.* From faulty technic in handling the stump, from adhesions due to accompanying lesions in the abdomen, from extensive manipulation of the viscera may result an ileus, mild or severe in type, depending on the particular cause. The same general principles must guide here as in the acute forms of appendicitis. The catastrophe is very rare in the chronic or clean cases, but may happen when least expected. Carlson and Marshall found the chief factors in obstruction were postoperative adhesions and that they may develop after "operations for clean appendicitis as well as from those with marked inflammation, perforation or abscess formation." They attribute a certain number of deaths from "acute dilatation of the stomach" to intestinal obstruction, even in simple cases of appendicitis. They observed cases of ileus occurring as early as two days and as long as eighteen years following operation. In twenty-one cases separation of adhesions was done eighteen times, resection of bowel once and enterostomy twice.

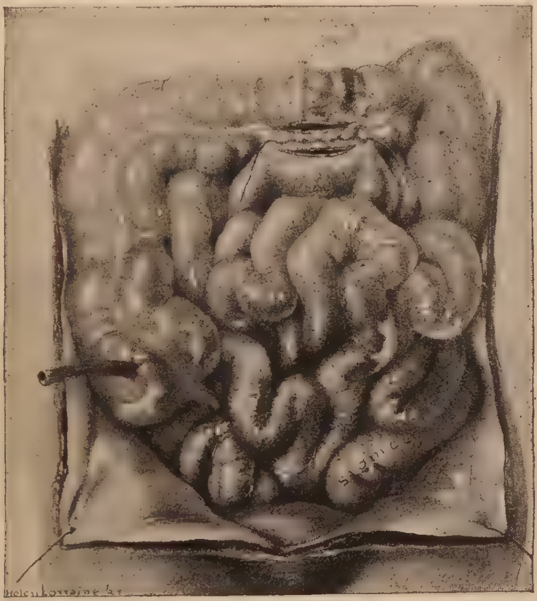

FIG. 56.—JEJUNOCOLOSTOMY FOR THE RELIEF OF "ILEUS DUPLEX."
(J. W. Long, after Handley.)

The treatment of *residual abscess* consists in locating the purulent collection and providing a way for its escape. Entrance can often be made through an already existing drainage tract, if this be present or an additional incision over the abscess can be made and other drains inserted. In cases not previously drained, the incision should be placed at the point to secure the best drainage. At times two or more incisions are needed.

The most troublesome of secondary abscesses to find and to treat are the *subdiaphragmatic suppurations* and the *liver abscesses*. When signs point to their presence their location should first be determined by an aspirating needle, and evacuation secured by open incision with free drainage. The place of choice for operation in the subphrenic abscess is posterior between the ribs about the level of the diaphragm. On account of pointing of the pus it may be necessary to make an anterior incision, draining there, from behind, or in both directions. These collections of pus are often exceedingly difficult to find and to drain. So many times their presence is not recognized or suspected until too late to cure the patient even by thorough evacuation.

Abscesses of the liver, resulting usually from an ascending pylephlebitis, are to be treated by incision and drainage as soon as verified. This will be very seldom done on time. It is almost impossible to distinguish between the infection of the veins alone and the early formation of liver abscesses. As the latter are nearly always multiple, emptying of one or two of them will effect no complete drainage. Solitary abscesses, which are extremely rare, furnish the only cases admitting a possibly favorable result. Approach may be had anteriorly or posteriorly according as tenderness or pointing may indicate. Adequate and long-continued drainage should be obtained, through and through, if possible. In spite of this most of the patients will die. General supporting treatment is needed both in pylephlebitis and in hepatic abscess.

SEQUELÆ

One of the important sequels of an operation for appendicitis is a *fecal fistula.* Several different factors enter into its causation: injury to the bowel during operation, gangrene of the cecum or the ileum, pressure-necrosis by a drainage tube, "blow-out" through the base of the appendix. In a few cases it is difficult or impossible during the operation to tie off the appendix stump or even to locate the opening on account of sloughing. Gentle separation of adhesions will prevent tearing of the intestine, very often done without being discovered. If gangrenous spots are seen upon the cecum or the ileum they may be infolded by suture, forestalling rupture. Drainage tubes should be so guarded as to protect any portion of the intestine with which they may come in contact. Naked gauze drains are taboo. Many fecal fistulæ will close spontaneously in a few days to a few weeks after operation; those in the cecum almost invariably, those of the small bowel almost never. In any case that persists operation is demanded for its closure.

Intestinal fistulæ due to specific forms of disease, as tuberculosis, cancer, and actinomycosis, do not show a natural tendency to heal, but must be dealt with by excision or exclusion of a definite segment. These pathological processes usually are not limited to the appendix, but extend to the cecum, ileum and perhaps to other parts.

The tuberculous variety is the most frequent. They are all difficult to cure. According to Alglave the operation of choice for the closure of fecal fistulæ complicating appendicular tuberculosis is bilateral exclusion of the diseased part of the intestine, for treatment of the fistula itself will fail. Incisions should be placed on the ileum 15 to 20 centimeters above the ileocecal valve and on the colon about 20 to 25 centimeters below, with every effort to save as much of the large bowel as possible.

Following removal of an appendix, which has been the seat of actinomycosis primarily or by extension from the cecum, fistulæ almost invariably result. The abdominal wall in the right iliac region becomes involved; the skin is thickened, edematous and purplish-violet in color; there is dense induration, very little pus, and usually no intestinal obstructive symptoms. The mass is larger and more fixed than in tuberculosis or cancer of the cecum. The condition is very serious and generally demands radical removal of the cecum and part of the ileum, along with as much of the abdominal parietes as possible. Bevan's experience with copper sulphate has been favorable. He administers ¼–½ grain internally three times a day and irrigates the lesions with a 1 per cent solution. This appears to be the best treatment to employ.

Attempts to close the fistulæ too soon will only serve to make matters worse. If a reasonable time is allowed to elapse, simple suture, purse-string or Lembert, will suffice. Individuals with fistulæ are impatient, depressed, and inclined to retire from social sight and often importune the surgeon to operate before the accepted time. Conservative treatment—packing, applications, irrigations—is rarely effective. If any local measure is likely to succeed, it is the insertion deeply down into the sinus of tapes soaked in compound tincture of benzoin. I have had permanent closure to result in several instances from this method. The operative plan must be applied to the cases which finally do not yield to time or conservation, represented chiefly by those in the ileum or the mixed type in which both large and small intestine are implicated. Some form of intestinal switching may be needed and at times complete resection of the ileocolic segment is in order. In other words, operative treatment of these fistulæ may vary from an easy suturing of a small opening up to an important surgical procedure demanding considerable skill.

It must not be presumed that feculent discharge from a wound necessarily means an intestinal fistula. The odor of appendical pus containing the colon bacillus is the same as that issuing from the fecal stream itself. By the clearing up in a few days, or by the emission of true feces the question will be decided.

Concerning the frequency of fecal fistula the last report of Deaver is enlightening. He announces 222 cases following 4,655 operations for acute appendicitis. It must be understood that this experienced surgeon drains frequently and plentifully, using tubes, rubber-dam, and gauze. Of his 222 fistulæ eighty-six healed spontaneously, 108 required repair by operation. The rest, twenty-eight in number, were discharged, either because they refused operation or they went home promising to return for operation if needed and failed to do so. Returns from a follow-up service indicated that most of the latter cases healed of themselves and are to be included among those conservatively cured. In ten instances of the cases operated upon (108) there was a recurrence of the fistulæ, which for the most part healed later spontaneously.

Postoperative hernia is another sequela. It is an almost inevitable complication of the suppurative wound, especially if bulky drainage is employed through it. It may be seen after a clean wound if muscles have been cut across or peritoneum and fascia have not been nicely approximated. Long incisions certainly predispose to hernia. Undoubtedly one should drain through incisions if such procedure is demanded to save life and admittedly it is better to have a living patient with a hernia than a dead one with a firm wound; yet it is possible to secure the desirable ends of this dilemma, to save the incision and the patient, too. Thinking in terms of abdominal architecture while at the same time taking advantage of engineering knowledge for use within is the right attitude.

In certain cases postoperative hernias are quite unavoidable. All surgeons will experience them. As Whiteford remarks, "it is only in the practice of a surgeon who never operates that herniæ never occur." Much can be done, however, to prevent their development. Every suppurating incision does not yield a hernia. Pressure, lateral incision, Wright's solution compresses may limit or abort the infection, while adhesive strapping will retain the parts and reduce hernial incidence to a minimum. A method of diminishing postoperative hernia following operations has been used by F. E. Fowler. He uses the McBurney incision in all of his cases (182) and employed two cigarette drains: a long one deep in the cavity, to be removed in twelve to twenty-four hours and a short one just within the peritoneum to be removed in thirty-six to seventy-two hours. No suture material whatever is used. The incision is made very small, becoming narrower as it goes downward.

The question will come up whether to attempt an immediate closure while the edges are still granulating, or whether to postpone operation until the hernia has fully formed. In some cases the former course succeeds, but usually the latter is more satisfactory.

Inguinal hernia on the right side following appendicectomy has been noted by several observers. In the cases coming to our attention, few in number, it was observed that the incision was placed so low as to reach the internal ring, or to encroach upon the hernial canal. Other causes may be operative. A report by Oudard and Jean presents the findings in nine cases of adult males. Thirteen months was the average time after operation before the hernia developed. Within the sac in all cases, was seen chronically inflamed omentum, firmly attached by adhesions, with a thinner abdominal wall and an enlarged external ring. These authors believe that the omental adhesions occurred at the time of the appendical attack, or formed immediately after the operation, and regarded these adhesions as the primary pathogenic factor in the causation of the hernia. Injury of the muscles or the nerve supply to the muscles gave rise to the necessarily weakening of resistance. The hernial sac differed materially from the congenital type.

Pains persisting after appendicectomy may be included under sequelæ either in the acute or the chronic cases. Customarily these pains are laid to adhesions, often without examination or consideration of other possible causes. In my experience so-called "adhesions" are set up as factors more often after operations for chronic appendicitis than after those for acute appendicitis, and yet the latter must show by far the greater incidence and greater extent of adhesions. Roentgenologic study of such cases will show a rather small number in which adhesions, especially in chronic cases, play any part. My opinion coincides with that of Kuttner, who is convinced that often it is not adhesions which cause the complaints but in many cases an inflammatory catarrhal process featured by alternating constipation and diarrhea—symptoms, as a rule, present before operation, the appendix being only a part of a diffuse intestinal disease. Other factors, as gastric or duodenal ulcer, gall-bladder disease, adnexitis, pyelitis and a disturbed nervous system, contribute their share of persistent postoperative pain, affording examples of possible failures in complete diagnosis.

A collected report from private practice of three hundred cases in which appendicectomies had been performed without relief afforded a theme for investigation by Bettmann. Among the causes of failure were, in order of frequency, inadequate study of the patient and very imperfect indications for any operation; symptoms due to gastric or duodenal ulcers; cholecystitis and colitis; misleading x-ray reports. "Right iliac pain is a most deceptive sign. In from 40 to 50 per cent of the unsuccessful operations it remains for months and years after the operation."

MODIFICATIONS OF TECHNIC TO MEET UNUSUAL PATHOLOGICAL CONDITIONS

Occasionally such marked pathological reaction results after recurring attacks of appendicitis that it is difficult or impossible to apply the customary methods for removal of the appendix.

The retrograde method has been referred to as being reliable and safe especially in acute types. It is also very practicable in some of the chronic cases with deep-lying adhesions.

When unable to take hold of the appendix or to isolate it thoroughly, the operator must be resourceful enough to vary his method to accomplish the result. The principal contrivance is to close the appendix opening, adjusting everything else to attain this end. Fortunately the base of the appendix is the portion least often involved in infection or adhesions.

In over six thousand operations Lanz has been able always to apprehend the appendix except in five instances. These were handled by dividing the appendix with a thermocautery and leaving a clamp in place at the site. He named the procedure "appendekthlipsia." Four cases made an uninterrupted recovery; the other case developed fever, necessitating removal of the clamp, when the mucous tube came away as a whole, filled with pus. One of the cases returned a year later complaining of right abdominal pain and presenting a swelling there, the size of the finger tip. Removed under local anesthesia, it was an ovoid tumor as large as a hen's egg, an encapsulated cicatricial mass resembling a fibroma. Lanz defined it as a "spontaneous sequestration of the appendix which had been protected from renewed infection from the intestine by its separation."

For the conditions in which the previous writer would recommend "appendekthlipsia," Derganc employed "appendicolysis," or subserous appendicectomy. Approach to the base of the appendix is made by slitting the serous coat, the tube is slowly pulled through the opening as the finger is withdrawn from a glove, the adhesive covering drops back, and no further attention is needed. All of his cases, thirty-two in number, with one exception, healed without drainage, and without postoperative complications.

Such methods are by no means new. They have been in common use in one form or another for many years. "Skinning" the appendix may begin at the base, the tip or in the middle. It is like pulling a rat away from his own tail when its outer extremity is held fast.

A similar plan was adopted in a case just recorded by Walters and Synhorst, presenting a so-called "ligneous infection" of the appendix and cecum, a woody induration resulting from repeated attacks of subacute appendicitis. The appendix was buried in the dense posterior cecal wall, protruding only by its tip, which was seized and held while the serous and muscular coats were incised allowing the appendix to be wormed out, cut off and tied at its base

APPENDICOSTOMY

This procedure, first devised by Weir in 1902, consists in drawing the appendix through a small intermuscular incision in the abdominal wall, fixing it there, cutting off its end, and introducing a catheter into the lumen for the purpose of irrigating the colon. As expressed by its author, it was "a new use for the useless appendix in the treatment of obstinate colitis." For a while this was a very popular operation. It does not now seem so widely employed. Variations in the technic have been suggested from time to time. One particular phase seems to be needful: deferring the opening of the appendix for thirty-six to seventy-two hours after stitching its base—not too narrowly—to the parietal peritoneum in order to preclude contamination of the cavity.

The wide utility of appendicostomy was commended by Keetley, who, in addition to confirming its value in colitis, employed it largely for toxic conditions, nutrient enemas, as a safety valve in bowel resections, and conspicuously for constipation. He proposed a plan for permanent appendicostomy.

Quite recently Crawford advocates appendicostomy for the relief of thirst and inanition after abdominal operations. This is his technic:

"1. At the end of the main operation the appendix is palpated and freed from any lateral attachments so that it is supported by the mesentery alone.

"2. A small scalpel is placed on the middle finger and palm of the left hand and inserted into the abdomen. The tip of the middle finger is applied to the inside of the right abdominal wall about two inches internal to the right anterior superior iliac spine at the level of the appendix base. The knife is then pushed through the wall forwards and slightly outwards by flexing the wrist and hand.

"3. The knife blade is gripped by a small artery forceps and then pulled back into the abdomen, carrying with it the jaws of the forceps.

"4. The knife is removed from the jaws of the forceps and the tip of the appendix is substituted for it. The forceps is then pulled out, followed by the appendix. It is important not to twist the appendix, and palpation of the meso-appendix will determine whether or no this has happened. I have found that most of the appendix comes out without severe pulling, and there is apparently no need to be afraid of using some force.

"5. The mesentery is ligatured a quarter of an inch outside the skin and two sutures of silkworm gut are passed through the skin and appendix wall to anchor the latter.

"6. Finally, afer closing the main abdominal wound, the appendix is cut off half an inch from the skin. A small catheter is introduced for several inches and tied in. The dressing is arranged so that the catheter comes through and is controlled by a clip."

Before the patient leaves the table, one pint of saline and glucose solution is passed through a funnel into the colon and repeated as often as necessary, every three hours as a rule. In a perforated gastric ulcer case Crawford has given as much as seventeen pints in seventeen hours and watched the pulse fall from 144 to 70; the patient did not once ask for a drink by mouth. Nine cases in all represent his experience in this procedure; only one died, a gas bacillus infection of the liver from a gunshot wound, in which death occurred two weeks after operation.

Following appendicostomy the stump generally closes of itself without difficulty. Now and then nitrate of silver, compound tincture of benzoin and tincture of iodin are useful to stimulate granulation.

ANTIGANGRENOUS SEROTHERAPY IN APPENDICITIS

Unique and reassuring is the treatment proposed by Clavelin. In cases of gangrenous appendicitis, appendicular abscesses and generalized peritonitis, after getting rid of the source of infection, he introduces into the peritoneal cavity a serum both antitoxic and antibacterial for the organisms commonly found in appendicitis, containing antibodies against twenty-one different varieties of microbes both aërobic and anaërobic. After amputation of the appendix 40 c.c. of this serum is injected into the peritoneal cavity and the abdomen is closed without drainage. The patient is placed in the Fowler position, receives glucose by the rectum and another 40 c.c. of serum subcutaneously; in severe cases it is given intravenously—all to be repeated on the third and fifth postoperative days, if necessary. In Clavelin's forty-four cases there was not a single death, though many of them had diffuse peritonitis and no secondary abscesses occurred.

In an inflamed appendix Weinberg and Prevot discovered a highly virulent species of *Bacillus sporogenes,* agglutinated by a sporogenes antiserum refractory to the antiserum of septic vibrio. Fever persisted after appendicectomy and gas-gangrene antiserum was given, after which reduction of fever followed.

On the other hand Oudard and Coureaud made a review of 283 cases of appendicitis showing tables of bacteriologic findings and results of surgical treatment and reported two cases of perforated, gangrenous appendicitis with desperate postoperative symptoms, which were treated by antigangrenous serum with negative results. The serum consisted of antiperfringous, antiedematous, antivibrin and antihystolytic strains; 40 c.c. of each serum were given subcutaneously and 20 c.c. intravenously in 300 c.c. of an artificial medium.

TREATMENT OF APPENDICITIS BY X-RAY

Basing his belief upon the theory that a diseased condition of any organ in the body that is rich in lymphatics is capable of benefit by the x-ray, Ross asks if it is not reasonable to state that this is the treatment of election in appendicitis. He treated sixty-five cases in eleven years—forty-six chronic and nineteen acute—according to this method. Of these, seven came to operation later, six chronic and one acute. For x-ray treatment these claims are set forth by Ross:

"(*a*) With proper dosage the pain of appendicitis can be quickly relieved.

"(*b*) Spastic contraction of the cecal orifice is relieved and drainage of the appendix into the cecum established.

"(*c*) The lymphoid structure of the appendix can be destroyed and atrophy of the appendix produced.

"(*d*) It is necessary to give treatment every day until the pain and tenderness have been relieved. After the pain and tenderness have been relieved, several treatments, from two to ten day intervals, should be given to insure atrophy of the appendix."

Analysis of these statements may be in order. Relief of pain is granted. There is hardly sufficient proof that spastic contraction of the cecal orifice is relieved in this way. Long and careful investigation would be needed to demonstrate destruction of lymphoid tissue and atrophy of the appendix by the x-ray. Finally unless the diagnosis is checked up by operation, visualizing the "pathology of the living," errors must be admitted.

Promulgated with the best intentions, reported with the sincerest spirit, such methods as the above, along with the misnomer "medical" treatment of appendicitis, yet continue to result in great harm. In my opinion they are dangerous doctrines, not so much by what they do as by what they neglect to do; they inculcate sins of omission rather than of commission—and there is no health in them. So far as our studies go in the pathology of the disease, we have a right to say finally that once appendicitis, always appendicitis, and that when "the little assassin" is proved guilty beyond a reasonable doubt his execution should be forthwith accomplished.

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